EDITORIAL

THE final article of Mr. Dewell's series on Timber-Framing appears in this number. Announcement regarding the appearance of these articles in book-form appears on page 8 of the advertising section.

OUR attention has been called to the fact that the tramway at Christmas, Arizona, mentioned in the list of important tramways on page 49 of our February issue is the property of the Gila Copper Sulphide Company.

OILFIELD maps are of value to operators and others connected with the industry, but where development is active, they soon get out of date. For this reason we have compiled and are now ready to distribute a map of the McKittrick, Midway, and Sunset fields, corrected to March 1, 1917. Further particulars appear in our advertising section.

FIVE years ago this month, the first issue of this publication appeared. The intervening years have shown that an actual need for a magazine of this character exists, and that the usefulness of WESTERN ENGINEERING to the engineers and contractors on the Pacific Coast is increasing steadily. To our ever widening circle of readers and advertisers, as well as to ourselves, we wish many happy returns of the day!

DISSOLUTION of the Sacramento and San Joaquin Valley reclamation district would result in the suspension of the work of the Federal government upon the Sacramento river, in the opinion of both State engineer W. F. McClure and Major L. H. Rand, of the Engineer Corps of the War Department. The Chandler bill now before the Californian legislature providing for submission of the question of dissolution to the voters of the district, might easily have this result.

CONSTRUCTION by the United States Reclamation Service up to December 31, 1916, is summarized in a recent official statement. One hundred storage-dams, 42 masonry, 39 earth, and 19 rock-fill and crib, with a total volume of 13,000,000 cubic yards have been built. The total storage provided is 9,000,000 acre-feet. In addition, the Service has constructed 11,000 miles of canals and drains, 77,000 canal-structures, 5600 bridges, 6600 culverts, 385 miles of pipe-lines, 95 miles of flumes, 2800 miles of telephone-lines, and 438 miles of power-transmission lines. This work has required the excavation of 150,000,000 cubic yards of material. In 1916, 1,012,625 acres of land on 23,951 farms was irrigated.

ESTIMATING, in these days of rapidly rising prices, has become a hazardous occupation. Bids on several pieces of public work have been opened recently where the lowest bid was considerably more than the engineer's or architect's estimate prepared several months before, and upon which the bond issue or other appropriation was based. Where there is no way to increase the amount available without going through the entire procedure again, the authorities face a difficult problem. If they reject all bids and re-advertise, there is likely to be a further increase in prices before the bids are opened again, with the result of still higher bids. It is too much to expect the designer to be also a prophet, but where there is reason to expect an increase of cost of materials needed for a structure, it is advisable to make a particularly liberal estimate.

THE Adamson Act has been declared constitutional and the railroad strike is 'off.' As frequently happens, the decision was by a divided vote of the Court. In a situation of this kind, which is so different from anything that the framers of the Constitution could have conceived, considerations of public policy and the general trend of legislation and of judicial decisions must necessarily influence the minds of the judges. The Act and the decision sustaining it may be regarded as essentially an extension of a similar kind of Government control to that already existing with regard to railroad rates, to cover railroad wages and hours of labor. The trainmen have received a large increase in wages, which, we may feel sure, will be paid not by the railroads, but by the shippers, and ultimately by the general public. On the other hand, questions of wages and hours will no longer be a matter for negotiations between the trainmen and the companies alone, but will be settled by the Government. Thus, the paramount interest of the public in such matters is recognized. Whether or not this will prevent future railroad strikes entirely is a matter for conjecture, but it certainly renders a strike, and particularly a successful strike, improbable.

WAR will probably be declared about the time that this issue reaches our readers. It is probable that nearly all of those who have given thought to the matter have accepted the situation, regretting that such action has been forced upon us, and particularly regretting that the country is not better prepared for the work that is to come. Whether or not that work will include sending an army to Europe, a large number of men must be trained and equipped. The engineers of the country will have to take a prominent part in this un-

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dertaking. The first step toward equipping an army of any size was taken last summer, when an Industrial Preparedness Census of the entire country was taken by members of the National engineering societies. In the actual manufacture of equipment, engineers will have an important part. When it comes to the training of an army, it is unfortunately true that most engineers have still to train themselves. While some engineers have already received commissions in the Officers' Reserve Corps, the total is small compared to the number of engineer-officers that would be needed by even a comparatively small army, as armies go in these days. It is important that other engineers should take the necessary steps to qualify themselves for the service of their country. Engineers residing in the Bay cities in particular should avail themselves of the opportunity of attending the course of lectures now being delivered under the joint auspices of the War Department and the local branches of the five National engineering societies.

The Proposed Architects' Licensing Law

Last month we discussed some of the worst features of California Assembly Bill No. 1126, miscalled 'An Act Providing for Public Safety in Buildings.' Since that time the bill has been amended past all recognition, but still contains many objectionable provisions. Furthermore, at this writing, there appears to be grave danger of its becoming a law, since the architects have been whipped into line solidly behind the measure, while the engineers and other interested parties have thus far been somewhat half-hearted in their opposition.

At the preliminary hearing before the Judiciary Committee of the Assembly, on March 21, the bill was amended very materially, and further amendment is probable at the final hearing on March 30. Any summary of the bill that can be given at this writing will be somewhat inaccurate by the time it reaches our readers. It is, however, safe to say that any and all of the Protean forms that the bill may assume during its variegated career will be objectionable.

At last accounts, the main features of the bill were as follows: An examining board composed of four, count them, four architects, two engineers, and one professor of engineering, is to have charge of the issuance of certificates. Architects and also structural engineers now practising receive certificates without examination. Other persons must, as a pre-requisite to taking the examination, have had five years continuous experience in the employ of a holder of a certificate. The examination is to cover mathematics, structural design, plumbing, heating and ventilating, electrical work, etc., but the relative weights of the different subjects appear to be left to the examining board. The design of practically all structures except frame dwellings of not more than two stories, and temporary structures not used for human assemblage, is to be in charge of a holder of a certificate or his duly authorized representative. This exempts a contractor's temporary buildings from the provisions of the measure, but, apparently, most oil-field structures, power-plants, substations, pumping-plants, and many similar buildings would still come under the Act.

Since, as has already been pointed out, the bill has undergone, and is still undergoing, considerable amendment, criticism of individual provisions is somewhat superfluous. It is, however, safe to say that a bill that was admittedly so ill-considered as already to require such profuse amendment, should not be passed at this session of the legislature. If its proponents honestly believe that a licensing bill for architects and structural engineers is needed, they should withdraw the present measure, and spend the time until the next session of the legislature in consulting with the various interests affected. We believe that it will be found that no such law is needed, but even if legislation on this subject is still desired, it will then be possible to draft a measure that will, at any rate, do the least amount of harm. Whatever need of legislation may exist is certainly not of such desperate character as to warrant the passage of such a half-baked measure as is now proposed.

There is one feature of the bill that deserves special mention, since it is cleverly concealed from the casual reader of the measure. While the bill has been so amended as to allow comparative freedom to the structural engineer, it still would eliminate the general contractor from all classes of work coming within its provisions. The bill states that the construction of all such buildings shall be under the direct supervision of a holder of a certificate or of some one in his employ and responsible to him. From this provision it follows that each building must have a superintendent 'on the job' other than the general contractor. The salary of this superintendent is of necessity to be added to the total cost of the building to the owner. Now it is a fact well known to all those interested in building construction that the owner is always 'kicking' about the cost of the work. This added expense for a superintendent is not going to find favor in his eyes unless the architect proposes, since they will have a superintendent on the work, that they deal directly with the sub-contractors by calling for segregated bids. Whether this will actually save money, depends upon the kind of architect and the kind of superintendent employed, but, in any case, the general contractor is out of it.

Another feature of the bill as it stands that is particularly unjust, is the lack of recognition of the value of technical training. With the exception of architects and engineers already practising, all candidates for examination must spend five years in the employ of a holder of a certificate before taking the examination. The graduate of an architectural school and the graduate of a reform school are thus placed on the same basis.

Finally, the measure has the inherent defect of so many licensing bills, in that it throws the doors wide open to all those practising at the present time, and requires a long period of apprenticeship and the passage of a difficult examination from future candidates.

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REVIEW OF THE MONTH

BOND ISSUES for county highway systems in California appear to have about an even chance for their lives. Last fall we noted the success of the Sacramento County issue and the defeat of the one in Fresno county. During March an issue of $2,200,000 was voted in Tulare county, while a $1,500,000 issue was defeated in Santa Clara county. The proposed systems were similar, except that while in Tulare county all the highways to be constructed are to be paved with concrete, the Santa Clara County plan provided, in addition to the concrete-paved highways, for grading a number of mountain roads sorely in need of improved alignment and reduced grades, but which do not carry sufficient traffic to justify an expensive pavement.

IN NEITHER COUNTY was there much opposition to the construction of permanent highways as such, the main point of disagreement being between the advocates of raising the necessary funds by a direct tax during a period of years, and those that wished to do the work as soon as possible by means of a bond issue. Santa Clara county has already tried the direct-tax plan, raising about $300,000 each year for permanent road construction. In Tulare county it had recently been proposed to raise $400,000 for this purpose, and this would probably have been done if the bond issue had not been successful.

WHAT was the cause of the difference in attitude on the part of the voters in these two equally progressive counties? Tulare county has a large area, much of it high mountains, and a comparatively small population, mainly rural. After enduring alkali and adobe mud in winter and dust in summer for several decades, the citizens about the beginning of the present century thought that they saw a panacea for their road-troubles in use of crude-oil. They discovered, however, that while oil is of value for earth roads with light traffic, it is not suitable when the traffic is heavy, and that, furthermore, in the hot climate of the San Joaquin valley, the roads are likely to be at their softest at the season when the heaviest hauling is being done. With the exception of about 25 miles of State highway, there are no hard-surfaced roads in the county, outside of incorporated cities. Santa Clara county, on the other hand, is relatively small, and has about twice the population of Tulare county. Furthermore, at least half of the population is in incorporated cities, many of whose residents would be taxed for the bonds but would not be benefited directly by the roads. It is true that improved roads benefit the city motorists, and by contributing to the prosperity of the city's business men, help everyone indirectly. However, most of the support for the good-roads movement now comes from the farmer, who is weary of being marooned in a sea of mud. Again, Santa Clara county has a large amount of rock and gravel for road-building well-distributed within its borders, and has made good use of it in the past. In fact, good roads were a common thing in Santa Clara county, when travel in most of the rest of the State was a nightmare. It is true that these water-bound macadam and gravel roads have not stood the test of the heavy automobile traffic of recent years, but for light traffic they are still satisfactory, and, in any case, the greatest amount of travel is on the concrete-paved State highway or on the roads built by the county in recent years from the direct tax-levy, also mainly of concrete. It is unfortunate that some of the roads constructed from direct taxes were of a type that we now know is not suitable for heavy traffic, but it is to be presumed the Supervisors have learned their lesson by this time, and will confine themselves in the future to better kinds of construction. In view of all these facts, it is probably safe to assume that the people of Santa Clara county voted against the bonds because their roads in general are fair, and they preferred to improve them year by year from direct taxes, even though that method has not been entirely satisfactory in the past. In Tulare county, however, the people are evidently dissatisfied with their roads and do not wish to wait the necessary time to improve the entire system from the general tax-levy.

THIS QUESTION of bonds *versus* direct taxes is one that calls for serious consideration. On general principles, it is undoubtedly true that it is better to pay as you go than to run into debt, and this is just as true of a community as an individual. But no one questions the propriety of an individual's borrowing money if he is certain of making a considerably larger amount by so doing than the interest on the money. A carefully planned system of improved highways is an investment that should give good returns to the taxpayers not only in decreased hauling costs and general convenience, but also in decreased cost of maintenance. In Tulare county, the advocates of the bond issue called attention to the fact that the average cost of maintenance of the highways that are to be improved under the bond issue was $658 per mile in 1916, as against $315 per mile in 1910. It will be seen that even if this cost for the unimproved highways made no further increase, the saving in maintenance resulting from improvement would probably be sufficient to pay the interest on the bond issue.

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ANOTHER advantage of bonds as against direct taxes that is not always appreciated is in continuity of management. The personnel of a county Board of Supervisors may change in part every two years and entirely every four years, so that any program of direct-tax improvement is not likely to be carried to completion by the same persons who initiated it. Even if a definite program has been adopted there is no certainty that politics and 'log-rolling' between different parts of the county will not disturb it. While this danger is present to a certain extent with a bond issue, the election-call usually determines the distribution of the funds, and the appointment of a county highway commission insures a certain amount of continuity of management. Where the supervisors have charge of the construction, the work is usually completed during one term of office.

TRAFFIC in some counties is so light that any large expenditure for permanent improvements would not be justified. On others the present highway system may be so nearly adequate to the needs of the people that the necessary improvements can be financed best by direct taxes. In still other counties, the present highways are so far short of meeting the requirements of the community that a bond issue will prove a good investment. All this emphasizes the importance of a complete investigation of the entire problem, not merely running lines of stakes and preparing plans, specifications, and estimates of cost, but also taking a traffic-census and determining the type of improvement that is advisable for each road in view of all the conditions. For a highway commission composed of 'practical' men to go ahead and select the roads that they wish to improve and the kind of improvement is almost as absurd as to attempt to construct the highways without engineering supervision.

THE Federal Aid Road Act has proved a powerful incentive to the passage of highway legislation in several States. The legislature of New Mexico has passed a law creating a State Highway Commission, to be appointed by the Governor, and which is to appoint a State highway engineer. A system of State roads is to be designated by the Commission. Improvement of these roads is to be done under the direction of the State highway engineer, funds to be obtained from direct taxation and by diverting a part of the motor-vehicle fund, with or without contributions from the counties. The State Highway Commission is to appoint a county highway superintendent for each county or for two or more counties. Road construction and maintenance not under the direction of the State Highway Commission is to be in charge of the county highway superintendent, subject to the general control of the county commissioners. Provision is also made for co-operation between the Federal, State, and county authorities in highway construction under the Federal Aid Road Act.

IN Nevada, a State Highway Department has been created. Two main State highways have been designated and $40,000 appropriated for improving them. This may seem a small amount to those accustomed to the expenditures in other States, but it should be remembered that Nevada is sparsely populated. The main point about the measure is that it constitutes a recognition of the fact that the highway problem has become too large for the local authorities to handle alone.

OREGON has changed the personnel of her State Highway Commission from a body of *ex officio* members, whose principal qualification was that they had been elected to something else, to three members appointed by the Governor. Other measures providing for more co-operation between State and local road authorities have been passed. A $6,000,000 bond issue is to be submitted to the voters on June 4. This amount is to be expended upon State highways during the next five years, and will be in addition to $1,900,000 available during the next five years from the regular Federal Aid Road Fund, $1,270,000 available during the next ten years for roads in the National Forests, part of the motor-vehicle fund, and also any funds that may be voted by the counties. The entire system comprises over 4000 miles of highways, but only the most traveled roads are to be paved at the present time, the total paved mileage depending upon the extent of co-operation by the various counties. Provision is made for co-operation with the Federal government in highway construction. Since Multnomah county, in which Portland is situated, has nearly completed an adequate county highway system, all of the proposed expenditure is to be made in the rest of the State. Although Multnomah county pays 40% of the State taxes, and consequently 40% of the interest and sinking-fund of the bonds, most of the opposition to the measure appears to come from other parts of the State.

THE increased cost of steel since the outbreak of the War has made a steel bridge almost as expensive as a more permanent concrete structure. Bids were recently opened at Olympia, Washington, for the construction of a highway-bridge, alternate bids being received for a steel and a concrete structure. The five bids on steel construction ranged from $26,875 to $29,900, with an average of $28,115, and four bids on concrete from $27,987 to $31,000, with an average of $29,550. The only contractor to bid on both types bid only $1000 higher on concrete than on steel. The county authorities awarded the work to the lowest bidder on concrete construction.

FEDERAL aid for highway construction is not to be contingent upon the particular material used in the work. Even an earth road, provided it is substantial and is adequate for the traffic, may be submitted for approval.

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DISCUSSION

Formula for Flow in Wood-Stave Pipe

The Editor:

Sir—In your issue of January 1917, on page 18, you have reproduced F. C. Scobey's chart in relation to the flow of water in wood-stave pipe, and, also on the same page, have given his formula.

Directly under the formula the nomenclature gives *D* as equalling inside diameter of pipe in inches. The diagram, of course, gives the diameters in inches, but your attention is called to page 7 of the U. S. Department of Agriculture, bulletin No. 376, on the 'Flow of Water in Wood-Stave Pipe' by Fred C. Scobey. The nomenclature for the formula given on page 7, which is the same as that given in your magazine, is outlined on page 3 of the above mentioned bulletin No. 376, and gives *D* as equalling the mean inside diameter of the pipe in feet. This error should be corrected so that when the formula is actually used instead of the diagram no mistake will be made.

Ross L. Mahon.

San Francisco, February 23.

Prevention of Misfires

The Editor:

Sir—In your February issue, there is an article by E. F. Brooks, on the 'Prevention of Misfires,' in which he states that it is unnecessary in the use of nitro-explosives to use tamping as the air itself will offer sufficient resistance. While it is true that air does offer sufficient resistance to the gases from exploding dynamite so that some portion of the strength is available for useful work, numerous experiments in actual work as well as the experience over many years in the field, prove beyond a doubt that adequate tamping or stemming is absolutely necessary to realize the full strength of any explosive. Tests have been made by the Bureau of Mines at its Pittsburg testing-station, which indicate that the use of the most efficient stemming material may increase the useful energy of a straight dynamite between 60 and 93%. A full report on the 'Effect of Stemming on the Efficiency of Explosives' is embodied in Technical Paper 17, Department of the Interior, Bureau of Mines.

Mr. Brooks also makes the statement that the cap crimper making a groove around the cap is to be preferred. While this type of crimper makes undoubtedly a more waterproof joint than the flat-sleeve type, our experience points to the fact that when the grooved type is used, gases form between the end of the fuse and the surface of the explosive charge in the cap, which cause misfires by smothering the fire or sparks from the fuse. Whatever the cause is, we have had many misfires in actual practice when this type of cap crimper was used, and on account of this, we changed our cap crimper from the grooved type to flat-sleeve type, which holds the cap securely on the fuse and allows the escape of the deadening gases, so that the end-spit of the fuse is not smothered.

Arthur LaMotte,
Manager Technical Division,
E. I. du Pont de Nemours & Co.

Wilmington, Delaware, February 19.

STATISTICS OF PRODUCTION OF CALIFORNIAN OILFIELDS

The *Standard Oil Bulletin* contains an historical summary of the production of the various Californian oilfields. The first oil in the State was produced in Ventura county in the early 60's. For many years all the petroleum produced in the State came from the Newhall field near Los Angeles and the Ventura County fields. The production has fluctuated, but in general there has been an increase. Since 1913 the production has been about 1,000,000 barrels per year. The first wells in the Los Angeles City fields were drilled in 1894. The production, including the Salt Lake field, reached its maximum, 5,138,000 barrels, in 1908. Since then it has decreased to one-third of that amount, and as there is practically no new development, will probably continue to decrease. The first wells at Summerland were drilled in 1890, but the first commercial production was in 1894. The maximum production was in 1899, 208,370 barrels. The present production is about 50,000 barrels per year, and a further decrease is probable. The first wells at Coalinga were also drilled in 1890, but there was no commercial production until 1896. The maximum production was in 1912, 19,500,000 barrels, and the production in 1916 was 14,380,000 barrels. The first wells at Sunset were drilled in 1891, but the field did not figure in the production column until 1900. The maximum production was 12,500,000 barrels in 1914, when the Lakeview No. 2 'gusher' was flowing. The production in 1916 was 6,750,000 barrels. The first wells at McKittrick were drilled in 1892, but there was no commercial production until 1898. The maximum production was 5,800,000 barrels, in 1909. The production in 1916 was 3,250,000 barrels. The first wells in the Kern River field were drilled in 1899, and the field almost immediately became the most important in the State. The maximum production was 17,250,000 barrels, in 1904. The production in 1916 was 8,400,000 barrels. The first wells in the Midway field were drilled in 1901, but the field was relatively unimportant until 1909. The maximum production was 37,500,000 barrels, in 1914, and the production in 1916 was nearly as much, 32,150,000 barrels.

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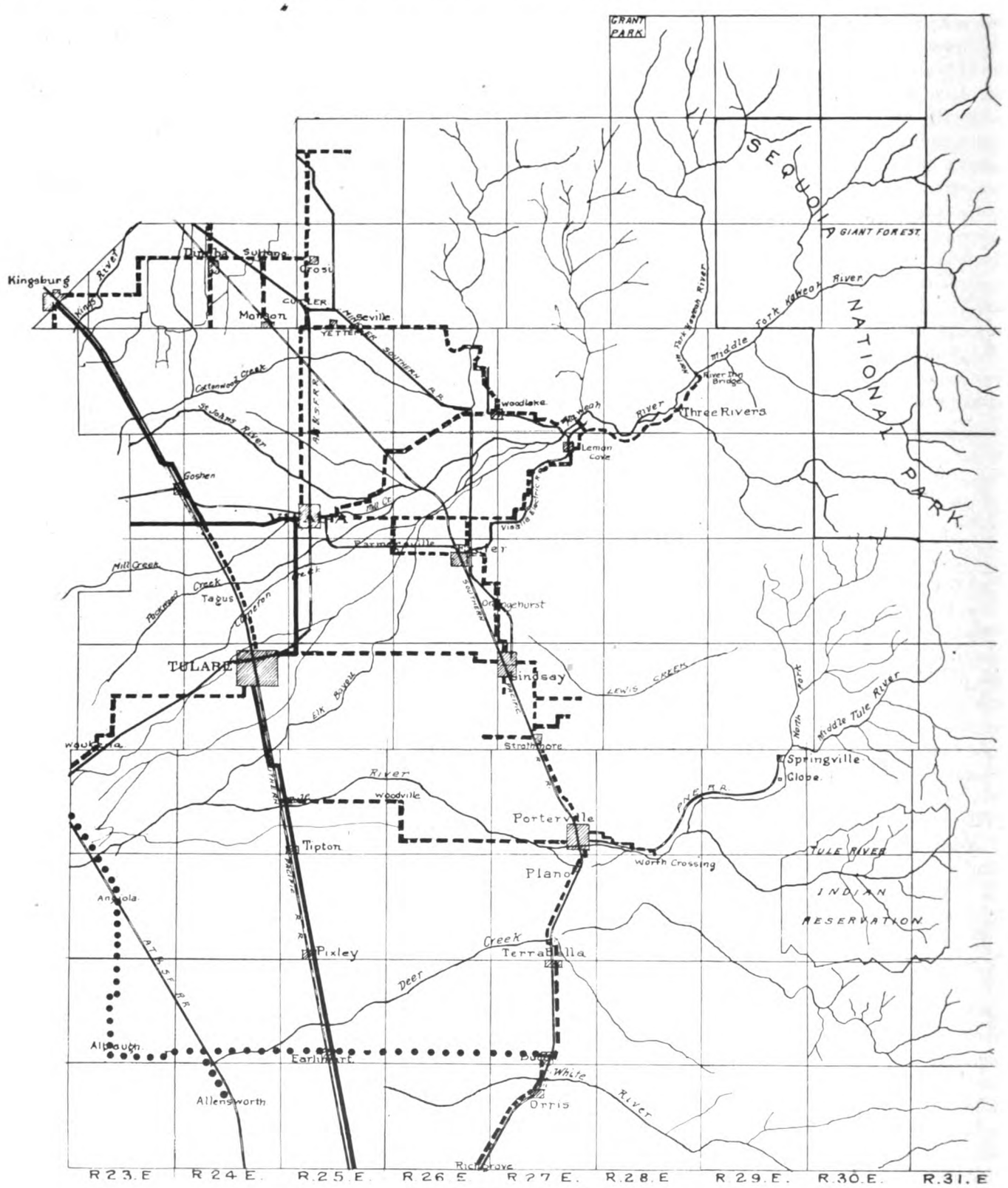
Highway System for Tulare County, California

On March 7 the voters of Tulare county, California, approved by considerably more than a two-thirds majority a bond issue of $2,200,000 for the construction of a county highway system. The bonds are to bear 5% interest, and are to be redeemed serially commencing with the 9th year and ending with the 24th year.



MAP OF PROPOSED SYSTEM.

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Assuming that the average cost of maintenance of the highways will be $50 per mile per year, the heaviest tax-rate for interest, maintenance, and bond-redemption will be in the 9th year, $0.573 per $100 assessed valuation, figured on the basis of the present assessment, which will undoubtedly be increased by that time. In this connection it is interesting to note that the total cost of maintenance alone of the roads in the county, a large part of which will be saved by paving the principal highways, was about $0.52 per $100 assessed valuation, and that this expense is over twice what it was in 1910.

The proposed system is shown on the accompanying map. The full lines show the State highway, 61 miles in all, about 25 miles of which has been constructed so far. The remainder of the State work will be done soon after the money from the $15,000,000 bond issue becomes available. The concrete-paved roads that will be built from the county bond issue, 220 miles in all, are shown by dash lines. In addition, the county proposes to construct 39 miles of oiled road, shown on the map by dotted lines. The roads are to have a concrete base 5 in. thick and a 1½-in. wearing surface. The pavement on the main highways is to be 16 ft. wide and on the less important roads, 12 ft. The grading will be light on nearly all the roads, about 2000 cu. yd. per mile on an average. Bridges and culverts will cost $300,000, which will be paid from the general fund of the county, not from the bond issue. Final surveys will be commenced about April 1, and it is expected to prepare plans and specifications so that bids for the first parts of the work can be opened during May, and that at least 80 miles of highway can be completed before next winter.

The election was held under section No. 4088 of the political code. In accordance with this section, the construction of the highways will be in charge of the Board of Supervisors and of the county surveyor, Byron O. Lovelace, who furnished the data upon which this article is based.

EFFECT OF ALKALI SOIL ON CEMENT-TILE AND ON CONCRETE BLOCKS

The U. S. Bureau of Standards commenced in 1914 a series of experiments on the durability of cement drain-tile and of concrete in general in alkali soil. A progress report on these experiments is shortly to appear as a bulletin of the Bureau of Standards. A summary of the bulletin appears in a recent number of the *Reclamation Record*. In general, the least porous tile is found to be the most durable. The following general conclusions are given regarding cement tile exposed to soils or water containing alkali salts in quantities of 0.1% or more.

1. Tile that is porous on account of the use of lean mixtures or relatively dry consistencies is subject to disintegration. Some dense tile is, under certain conditions, subject to surface disintegration.

2. Disintegration is manifested by physical disruption caused by the expansion resulting from the crystallization of salts in the pores, and by softening resulting from chemical action of the solutions with the constituents of the cement.

3. While results obtained will not permit a definite statement as to the relative effect of the various constituents of the salts, indications are that the greater the quantity of the sulphates and magnesia present, and the greater the total concentration of salts, the greater will be the disintegrating effect.

4. Tile made by the usual process, which allows the removal of forms immediately after casting, is subject to disintegration where exposed to soil or water containing 0.1% of alkali salts similar in composition to those encountered in this investigation.

5. Hand-tamped tile of plastic consistence as made in this investigation is not equal in quality to machine-made tile of the same mixture and does not resist disintegration from alkali as well, but hand-tamped tile of quaking consistence is the least porous and most resistant to alkali of all tile tested.

6. Steam-cured tile shows no greater resistance to alkali action than tile that is cured by systematic sprinkling with water.

7. Tile made of sand-cement has less resistance to alkali action than tile made of portland cement of the same proportions.

8. Ordinary coal-tar coating, cement-grout coating, or the introduction of ferrous sulphate into the cement mixture is not effective in preventing the absorption of alkali salts from the soil.

If cement drain-tile is to be used in soil or water containing alkali salts it should be made of good quality aggregates in proportions not leaner than one part portland cement to three parts aggregate. The consistence should preferably be quaking, which has proved the most resistant of all mixtures used. This is a wetter mixture than that generally used in commercial tile-plants, and will probably require the retention of the tile in the mold for several hours unless some means is found to hasten the hardening of the cement.

The experiments with concrete blocks in alkali soils have not reached the point where general conclusions can be drawn, but it is stated that for durability under such conditions, the concrete should be made of selected materials proportioned so as to obtain a dense mixture. As small an amount of mixing-water should be used as will allow the mass to be properly placed.

Petrolastic cement is used for roofing, for expansion joints, as a filler in different kinds of block-pavements, and for coating pipe. It has a higher melting-point and is less susceptible to temperature changes than ordinary asphaltum. Since asphaltic products are black, they absorb heat. Instances have been known where the air-temperature was 100° F. and the temperature of the asphaltum was 160° F. At this temperature, most asphaltic products will flow, but petrolastic cement will not.

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Timber Framing—Part X

By HENRY D. DEWELL*

Miscellaneous Structures

In the preceding articles I have endeavored to present the underlying principles of structural mechanics as applied to timber framing, to show that timber construction is worthy of the same study as construction in steel or concrete, and to point out details of framing that best fulfil the requirements of the particular structure under consideration. This presentation has been in somewhat logical order, based upon the various structural features of a timber-framed building. Thus the articles have considered in sequence: grading-rules, working-stresses, washers and pins, strength of nailed, screwed, and bolted timber-joints, the design of typical truss-joints, design of truss-members, bracing, columns, joist and girder connections, and foundations. While the discussion has been limited almost wholly to building design, it does not follow that the principles, methods of design, and details are applicable only to timber-framed buildings. The building has been chosen rather as an example, for the reason that the design and construction of a large timber building of the mill-building type includes practically all of the problems that will arise in timber-framing.

When other structures, such as bridges, trestles, towers, flumes, etc., are considered from a structural standpoint, the loads and their applications, and also the allowable working-stresses, may vary, but the same principles of design will hold. Many of the details of connections that are used in building construction may be employed in these other types of structures. As was stated in the opening article, timber railroad-structures, such as a combination timber and steel bridge, or a timber trestle, are well standardized. The same is true of the larger highway bridges. To a considerably less degree, flume-design follows certain standards.

In the present article, there is presented a somewhat superficial treatment of a few timber structures that may be classed as 'miscellaneous structures.' In the order of their discussion, these are (1) flumes, (2) head-frames, and (3) water-towers.

Flume-Design. To illustrate a typical problem in flume-design a timber flume will be assumed 9 ft. wide on the inside, and with a maximum depth of water of 5 ft. 3 in., as shown in Fig. 79. Further, it will be assumed that the timber is not Douglas fir, but Californian mountain pine. The following unit working-stresses will govern the design:

Tension and bending, 800 lb. per sq. in.

Bearing across fibres, 200 lb. per sq. in.

Bearing against the ends of the fibres, 700 lb. per sq. in.

Longitudinal shear, 100 lb. per sq. in.

The figure shows the typical section as framed, and the sizes of the different members. The details of connections are found as follows. The cross-ties will be placed 3 in. above the flow-line and the bents will be spaced 2 ft. 8 in. centre to centre.

Detail Calculations

(1) Vertical post.

Total pressure per lin. ft. $= P = \frac{1}{2} \times 62.5 \times (5.25)^2 = 860$ lb.

This pressure acts at $\frac{3}{5}$ of the depth of the water.

The reactions at A and B are then

Pressure at $A = P_1 = \frac{1.75}{5.50} \times 860$ lb. $\times 2.67 = 735$ lb.

Pressure at $B = P_2 = \frac{3.75}{5.50} \times 860$ lb. $\times 2.67 = 1565$ lb.

In determining the moment on the post, such moment may be found by considering the total pressure P as uniformly distributed along the length of post. This method is not exact, but is approximately correct.

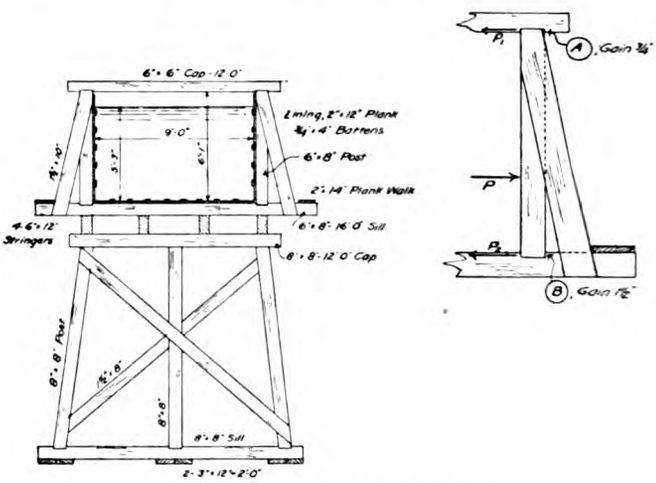

FIG. 79. CROSS-SECTION OF FLUME.

$M = \frac{1}{8} \times 2300$ lb. $\times 5.50$ ft. $= 1580$ lb.-ft.

The resisting moment of a 6 by 6-in. timber is 2400 lb.-ft., while the maximum resisting moment of a 4 by 6-in. timber is 1600 lb.-ft., both computed at 800 lb. per sq. in., maximum unit fibre-stress in bending.

The post will be gained into the cross-tie at the top and into the sill at the bottom. The required bearing-areas at the top and bottom, are then

Area at $A = \frac{735}{200} = 3.68$ sq. in.

Area at $B = \frac{1565}{200} = 7.87$ sq. in.

If the posts, cross-ties, and sills are 6 in. wide, the gain at the top must be $\frac{3}{4}$ in., and the gain in the sill $1\frac{3}{4}$ inches.

(2) Stringers.

*Consulting engineer, Holbrook Bdg., San Francisco, formerly Chief Structural Engineer, Panama-Pacific International Exposition.

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The trestle bents will be assumed to be spaced 8 ft. centre to centre.
The load on one stringer will then be
Water, $3.25 \times 8 \times 5.25 \times 62.5 = 8530$ lb.
400
Flume, assume weight, 8930 lb., say 9000 lb.
Moment on stringer $= \frac{1}{8} \times 9000 \times 8 = 9000$ lb.-ft.
Resisting moment of 6 by 10 in. timber $= 6650$ lb.-ft.
Resisting moment of 6 by 12 in. timber $= 9600$ lb.-ft.

The above calculations indicate that the vertical posts, cross-ties, and sills could be 4 by 6 in., the posts to be gained 1 in. into the cross-ties, and 2 in. into the sills. The cross-ties, as far as requirements of strength are concerned, could be made 4 by 4 in. This design, with the detail computations, has been taken from an actual case, a flume intended for a hydro-electric development. The sizes actually used were: cross-ties, 6 by 6 in.; posts, 6 by 8 in.; sills, 6 by 8 in.; and stringers, 6 by 12 in. See Fig. 79, which also shows the substructure. The engineers in this case used their calculations more as a general guide as to minimum requirements than to determine the actual sizes, and judgment and experience influenced the selection of practically every section. In

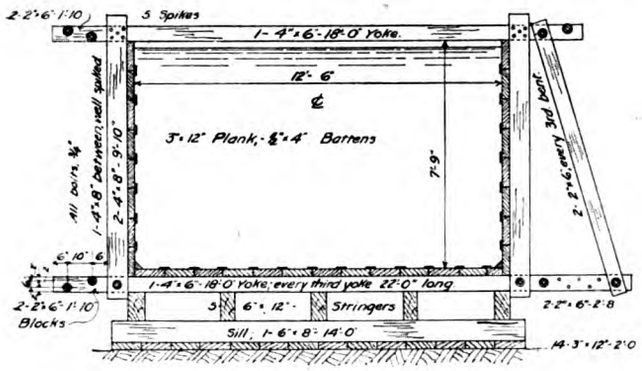

FIG. 80. CROSS-SECTION OF FLUME AT EXPOSITION.

this case, also, the decay of the timber through alternate wetting and drying was considered in employing sections larger than required by computations for actual strength. Standard practice has determined certain minimum sizes of timber for use in such cases: for larger flumes, requiring larger sections from a purely theoretical standpoint, the margin of safety to provide against decay could be reduced and the actual sections used would be nearer the sections determined from considerations of strength alone.

As an illustration of a larger flume, Fig. 80 shows one flume used in the filtration-plant of the Panama-Pacific International Exposition. This flume is 7 ft. 9 in. high, and 12 ft. 6 in. wide. The side-posts are two 3 by 8 in. timbers, bolted and spiked to a 4 by 6 in. sill and a 4 by 6 in. cap, or yoke. Between the bottom and top yoke is a 3 by 8 in. filler, which stiffens the side-posts. In addition to the bolting and spiking of the posts to the top and bottom yokes, short wooden blocks were bolted and spiked to each yoke to receive the thrust of the posts. The side-posts were spaced 4 ft. centre to centre. Every third post was braced to the sills by two 2 by 6 in. braces. The flume was carried by five 6 by 12 in. stringers, having a span of 12 ft., the stringers being supported by 8 by 12 in. sills, resting upon 3 by 12 in. plank. All material was Douglas fir. As the plant was of a temporary nature, the sections were determined from considerations of strength and deflection alone. In flumes of this size, deflection of the stringers, and of the side-posts must be taken into consideration, as leakage may result if there is appreciable deflection in the side-posts or the sills under load.

Two types of joints for the flume-lining were used; one, using $\frac{1}{2}$ by 4 in. battens with asphaltum in the joints, and the second an untreated spline-joint. The superintendent of the plant favored the results obtained from the spline-joint. I inspected the plant carefully several times, and as far as I was able to determine by observation, neither joint showed any material advantage over the other. Both were almost free from leakage.

In *Engineering News,* Vol. 76, No. 23, December 21, 1916, there occurs an article entitled 'Rectangular Wooden Flumes' by J. C. Stevens. Mr. Stevens treats of many practical details of timber-flume construction, but makes what I consider a radical statement to the effect that it is a waste of lumber to place battens on the inside of a flume. His recommendation is to place the battens on the outside of the sides, and on the underside of the floor, cutting them between the posts and sills. This is not the common practice on the Pacific Coast, where there are many large hydraulic enterprises using timber flumes. In triangular logging-flumes,[1] the battens are usually placed on the outside of the flume, and are often made continuous, the side-supports being cut accordingly. However, the two cases are not at all comparable.

Head-Frame for a Mine. Without going into an extended discussion of the design of head-frames, it is desired to give one example of the application to a timber head-frame of some of the principles and details advocated in preceding articles. For this purpose, there is shown in Fig. 82, a typical head-frame, taken from the *Engineering and Mining Journal* of October 11, 1913. The cut is from an article describing different types of timber head-frames. Sufficient data are not given by either the article or illustration to enable any of the stresses to be computed, and consequently no stress-analysis has been made. Indeed considerations of stiffness of the frame under working-conditions will require more bracing than might be computed from conditions of actual load and wind-forces. In a structure of this nature it is highly desirable not only that it shall be rigid under the racking received in the hoisting and dumping of ore, but also that the details are such that the joints may be kept tight.

Referring to the figure, the first criticism to be made is of the use of diagonal steel rods and horizontal struts of timber. Not only is this the most expensive system of framing under the usual conditions, where steel is expensive, and timber is comparatively cheap, but it re-

[1] See Bulletin No. 87, U. S. Department of Agriculture, 'Flumes and Fluming,' by Eugene S. Bruce.

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sults in bad details at the joints, making the whole structure difficult to tighten. With the rods horizontal, and the struts in an inclined position, the amount of steel would be the minimum, and the timber, while greater in quantity, would not add appreciably to the cost of the structure, and would be more than offset by the saving in other features. Consider one of the panel-points of the frame, where two rods intersect with the vertical post. Not only is the post cut to receive the horizontal strut, but in addition, two inclined holes of considerable size must be bored through the post at the same point, greatly weakening the post. It is safe to say, without knowing the size of all the rods, that 25% of the post is cut away. While this proportion may not seem to be large in itself, in this case it represents an area of some 60 sq. in. of timber that is useless. Expressed in other terms, an area equivalent to a 6 by 10-in. stick is not available. With such a detail, large sticks are a necessity.

Near the top of the head-frame, the inclination of the rods is considerable. It is evident that to pull the posts snugly against the horizontal struts, there must be exerted on the nut of the rod a force approximately twice that which is actually pulling the rear and front posts together. In other words, a large proportion of the stress in the rod, when tightening is in progress, is exerted in a vain attempt to lift the whole frame from its foundations. On the other hand, if the rods were horizontal, every pound of stress placed upon them when tightening the nuts would be exerted in pulling the posts tightly against the inclined struts. This statement is, needless to say, based on the assumption that the washers are large enough to prevent their being crushed into the timber of the posts.

A similar criticism may be made of the system of bracing below the loading-floor. Here would seem to be an excellent opportunity to use a truss of the Howe type, which would serve to carry the weight of the loaded floor to the supports, and could also be utilized to brace the whole frame against lateral forces. For this purpose, the bays of the truss should be counter-braced, and special attention should be paid to the end-connections of of the truss, to see that they are capable of transferring both tension and compression to the posts.

With the design shown in Fig. 82, it is hard to see how tension could ever exist in any but the main posts of the head-frame. It will be seen that the two intermediate posts are anchored to the concrete foundations. Apparently, however, there is no definite connection between these intermediate or minor posts and the main frame.

The final point of criticism in the design is the type of post-anchorage. Since the details are shown to a small scale, it is difficult to be sure just what such details are. It would appear that the anchorage consists of steel straps or anchor-rods flattened at one end to straps, buried in the concrete, and bolted through the posts. If the actual tension that may come into the posts is small, this detail may be entirely satisfactory; in fact, it is not my intention to imply that such a type of detail may not be strong enough in any case. There can be no chance of failure, provided that length of anchorage, size of strap-bolts, and number and size of bolts are sufficient for the stresses they will be called upon to carry. But, as was pointed out in the previous article, such a detail, once in place can never be tightened. It would seem therefore, that a detail which could be adjusted at any time by

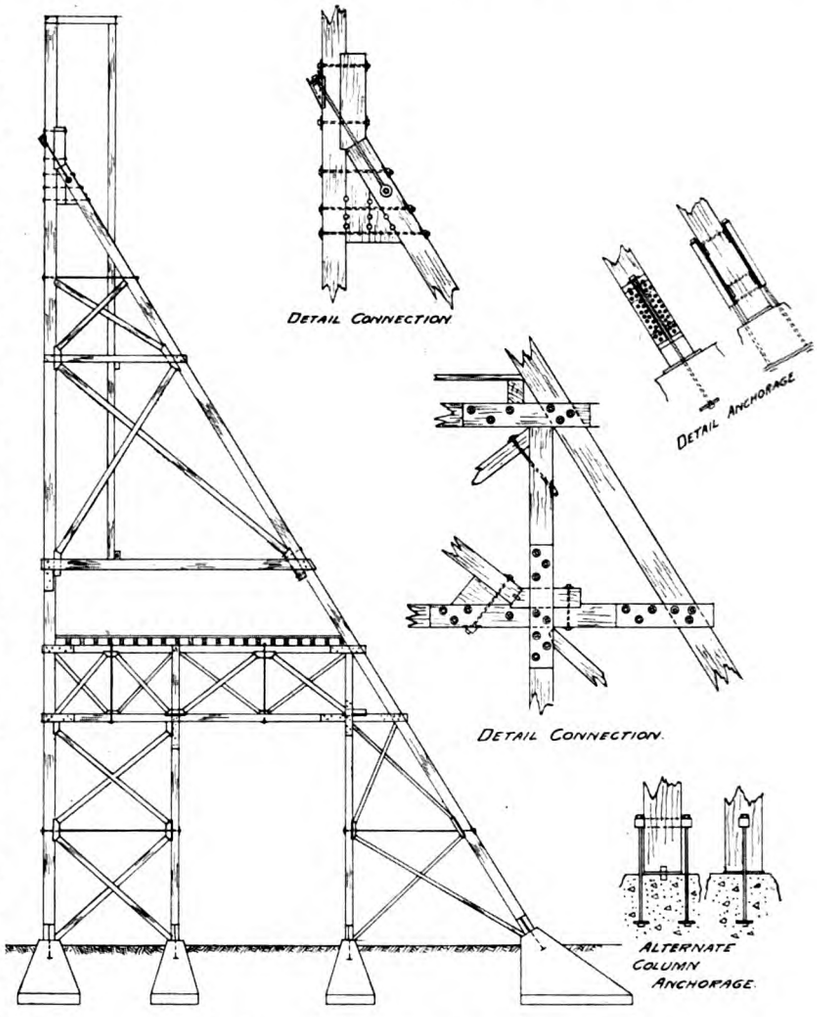

FIG. 81. REVISED DESIGN OF HEAD-FRAME.

tightening the nuts of the anchor-rods would be advisable, particularly as such a type of detail would not necessarily be any more expensive.

In order to emphasize the criticisms of Fig. 82 that have been made, there is shown in Fig. 81 a revised elevation of the head-frame, with some of the most important connections detailed. The two main posts have been reduced in size, since with the type of connections used, a much larger proportion of their section is available for use. No sizes have been noted on any of the rods or timbers; without knowing the loads there has been no attempt to compute stresses. The tie-rods have been

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placed in a horizontal position, and the diagonal members made compression timbers. Where two such diagonal struts intersect on the posts at a common point, butt-blocks have been used. For the support for the loading-floor a truss has been introduced, bolted at its ends to the main posts by means of splice-pads. The first vertical post to the left of the main inclined post of the frame, has been moved in to the left from its former posi-

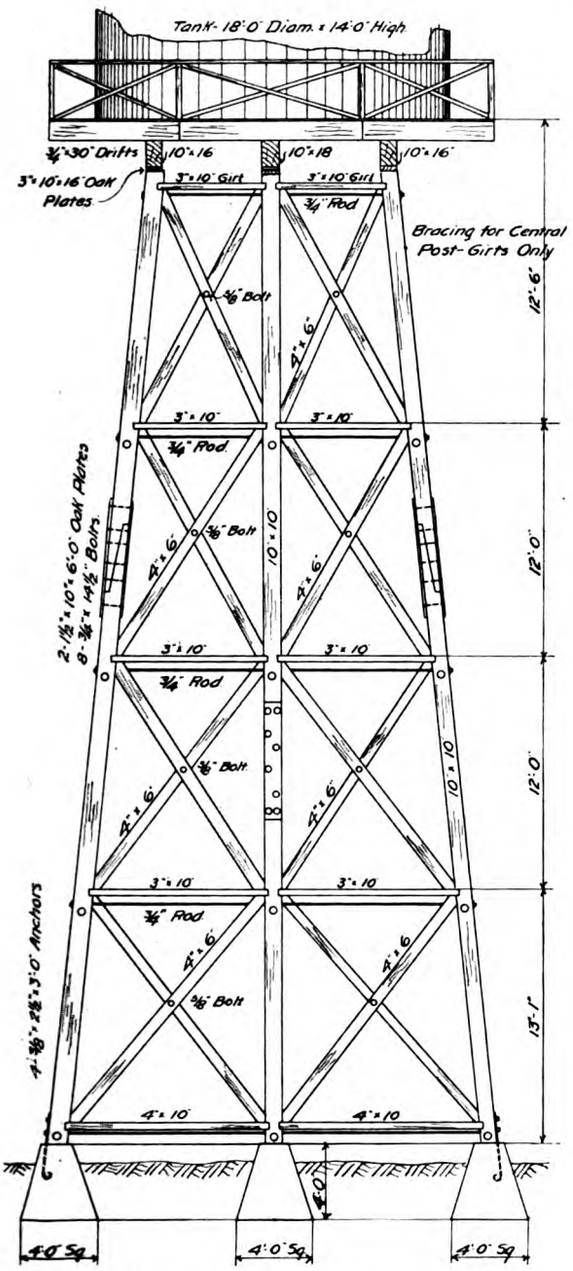

FIG. 83. ORIGINAL DESIGN OF TANK-TOWER.

tion. This is to enable a more positive tie to be made at its upper end to the cross-truss, and also to allow another system of cross-bracing to be introduced. Clearance for cars would determine the position of this post.

Suitable washers of generous area should be provided for all bolts and rods, so that crushing of the fibres of the timber would not occur. This provision will add much to the life of the structure. It would also be advisable to treat thoroughly the contact faces of all timbers, and the contact faces of all metal and timber with a good wood-preservative. The life of the head-frame will be lengthened by painting the inside of all bolt and rod-holes in the timber, the ends of struts, and the cut-faces of the timbers into which the ends of the struts and the butt-blocks fit. It might even be advisable to use castings at all panel-points, similar to the construction used in standard timber railroad-bridges, even though the stresses might not, and probably will not, require the use of such castings. Metal base-plates under all posts are a necessity to prevent moisture from creeping up the timber.

Water-Tower. One more type of miscellaneous structures will be discussed in this article, namely, a water-tower. An example from actual practice will again be chosen, and an alternative design shown. In this case the first design (see Fig. 83), was submitted by a firm manufacturing and selling wooden tanks and pipes. Fig. 85 shows the tower as actually built.

The principal points of difference between the design of Fig. 83 and 85 are (1) the omission of the column splices, in Fig. 85 (2) the change in details of the inter-

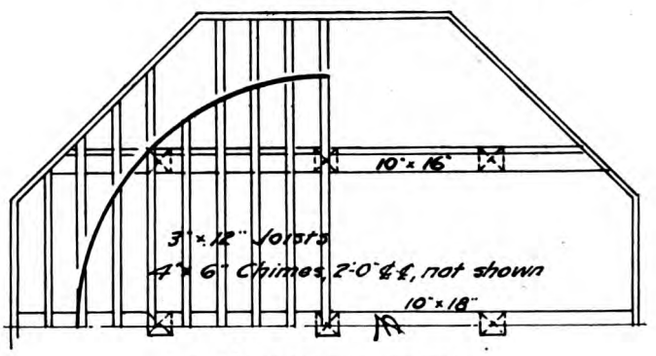

FIG. 84. FLOOR-PLAN FOR TANK.

sections of the diagonal struts with the posts, and (3) the revision of the post-anchorages.

Taking up these three points in the order mentioned, not only is a saving in cost made in the revised design by the omission of the column-splices, but a much stronger tower is secured. Attention is called to the splice proposed by the tank-manufacturers. The type of splice may be classed as the oblique scarfed joint with fish-plates. In a previous article objection has been made to this type of splice for timbers carrying heavy compression, because of the two surfaces of contact, requiring an accurate fit to be made. The fish-plates as required in the design were two $1\frac{1}{2}$ by 10 in. by 6 ft. oak plates, fastened with eight $\frac{3}{4}$ by $14\frac{1}{2}$-in. bolts. Why oak was required is not clear. The strength of oak in end-bearing and in cross-bending is practically the same as Douglas fir, of which latter timber the posts are composed. The shearing strength of oak is not quite 25% greater than that of Douglas fir. The fear of splitting the splices if they were made of Douglas fir may have influenced the designer to substitute oak. If, however, splices were necessary, which in this case they were not,

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as the length of the posts is not abnormal, and long timbers were easy to obtain, a better detail would have been secured by using a straight normal cut for the post, and thicker splice-plates of Douglas fir.

The detail of the intersection of the inclined struts with the posts is, perhaps, the worst feature of the design of Fig. 83. Note that the horizontal 3 by 10-in. girts are set into the posts approximately one-fourth of the depth of the posts. A note appears on the drawings, 'Bracing for central post-girts only.' On this design over 50% of the cross-sectional area of the central post is in cross-bearing on the timber. A rough calculation indicates that the unit compression on the central post is 320 lb. per sq. in. for dead load with no wind. While this unit compression is not excessive, it is evidently more than the designer anticipated, since 3 by 10-in. oak plates are specified between the tops of the posts and the bottom of the stringers. The inclined braces bear directly across the fibres of the 3 by 10-in. girts. This is a poor detail, both on account of unit bearing-pressures, and of timber-shrinkage. The girts will shrink and leave a somewhat loose fit between post, girt, and braces.

The third point is the anchorage for the posts to the foundation. Each of the four corner-posts is tied into the concrete foundations by one $\frac{3}{8}$ by $2\frac{1}{2}$-in. tie-strap, fastened with two bolts, presumably $\frac{3}{4}$ in. diam. The strength of such anchorage, measured by the safe resistance of the bolts is not over 3000 lb., measured by the tie-strap in tension, 10,000 lb., and by the weight of the concrete, 5472 pounds.

Turning to the revised design, as shown in Fig. 85, it will be seen that the post-splices have been omitted and the connection of inclined struts modified by introducing butt-blocks set into the posts; the latter change brings all post-timbers in end-bearing, and frees the joints from the effect of shrinkage of the timber, since the shrinkage of Douglas fir parallel to the fibres is small, and negligible for ordinary lengths of timber. The horizontal tie-rods now extend through the three outside posts. It is therefore necessary that horizontal struts be used in addition to the rods, in order that the increment of wind-shear may be transferred across the posts, from one system of bracing to the other. A more effective manner of handling this problem, although more expensive, would have been to have placed a turnbuckle on either side of the middle exterior posts. It is evident, that, with wind on the tower, the stress in any horizontal tie-rod will not be the same on both sides of the post in the revised design, the difference of shear must be carried from one corner-post to the opposite one and back to the middle post by compression in the two 2 by 8-in. girts. The central post is tied to the exterior posts by two 2 by 8-in. girts, in two directions, the girts being bolted to the posts. These girts are therefore able to develop both compression and tension. Finally, the size of the column-footings has been increased, steel base-plates introduced, and the anchorages strengthened, each post having two anchor-straps lag-screwed into the posts.

In the re-design of the tower, a wind-load of 30 lb. per sq. ft. of exposed surface was used. It should be stated that the tower was to be completely inclosed, and that it stood on the top of a hill, exposed to the full force of the wind on the entire surface of structure enclosing

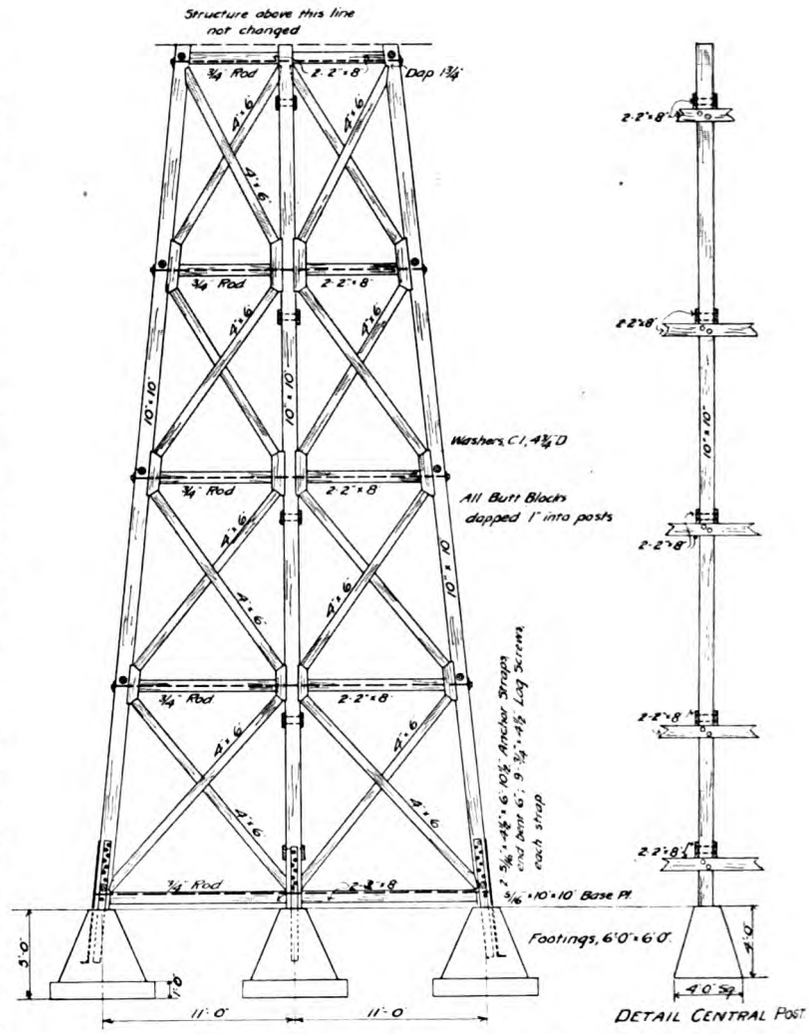

FIG. 85. REVISED DESIGN OF TANK-TOWER.

the tower. The rather heavy anchorages are therefore justifiable.

Wind-Pressure and Wind-Stresses

The subject of wind-pressure and wind-stresses is an unsatisfactory one to consider. There is a wide variation in opinion as to the wind-pressure that should be adopted for different types of structures, and for different heights of the same structure. Again, there is a wide difference in opinion as to what unit-stresses should be allowed in designing for wind. Finally, several

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methods are in use for finding the stresses resulting from wind. The latter statement applies more particularly to steel-framed office-building design than to the mill-building type of structure.

In order to bring out these points more clearly, I quote from Milo S. Ketchum's 'Structural Engineers' Handbook.' This authority specifies in regard to mill-buildings, as follows:

"Wind Loads. The normal wind-pressures on trusses shall be computed by Duchemin's formula, with $P =$ 30 lb. per sq. ft., except for buildings in exposed locations, where $P = 40$ lb. per sq. ft. shall be used.

"The sides and ends of buildings shall be computed for a normal wind-load of 20 lb. per sq. ft. of exposed surface for buildings 30 ft. and less to the eaves; 30 lb. per sq. ft. of exposed surface for buildings 60 ft. to the eaves, and in proportion for intermediate heights."

Also, after defining the unit working-stresses for dead and live loads,

"When combined direct and flexural stress due to wind is considered, 50% may be added to the allowable tensile and compressive stresses."

In the case of steel highway-bridges, Mr. Ketchum specifies as follows:

Wind Loads. The top lateral bracing in deck-bridges and the bottom lateral bracing in through-bridges, shall be designed to resist a lateral wind-load of 300 lb. for each foot of span; 150 lb. of this to be treated as a mov ing load.

"The bottom lateral bracing in deck-bridges, and the top lateral bracing in through-bridges, shall be designed to resist a lateral wind-force of 150 lb. for each foot of span. In bridges with sway-bracing, one-half of the wind-load may be assumed to pass to the lower chord through the sway-bracing. For spans exceeding 300 ft., add in each of the above cases 10 lb. additional for each additional 30 feet.

"In trestle-towers, the bracing and columns shall be designed to resist the following lateral forces, in addition to the stresses due to dead and live loads: The trusses loaded or unloaded, the lateral pressures specified above; and a lateral pressure of 100 lb. for each vertical linear foot of trestle-bent."

For direct wind-stresses, not combined with flexural wind-stresses, the above specifications allow an increase of 25% in the unit working-stresses; when direct and flexural wind-stresses are combined with dead and live load stresses, the unit working-stresses may be increased 50%. These specifications, while for steel structures, should also apply to timber structures, except possibly as regards the increase in unit working-stresses.

In the case of buildings of the mill type, a number of experiments have been made on small models, some of which would indicate that the ordinary assumptions as to the action of wind on buildings of this type do not hold. Albert Smith of Purdue University has found that in some instances there is tension in certain truss-members which by the commonly accepted method of design would take compression, and vice versa. In other words, he finds a suction on certain portions of the roof in such a building, instead of a pressure, or instead of neither suction nor pressure, as would be shown by the ordinary analysis.

Wind-pressure on a building produces bending in the columns, just how much bending is a disputed question.[2] There is no doubt that the specifications of Mr. Ketchum, if followed consistently, will result in a building of safe design. The question to be decided by the engineer is whether or not, such specifications, when applied to timber buildings, are too severe.

R. Fleming, of the American Bridge Company, has made a study of all available discussions in technical literature on this subject, and has published several articles on the subject in the *Engineering News*. Recently, in an endeavor to standardize the various conflicting specifications, he has proposed a set of Specifications for Structural Steel Work.[3]

On the subject of wind-pressure, Mr. Fleming proposes the following specifications:

"Wind-Pressure. All steel buildings shall be designed to carry wind-pressure to the ground by steel-framework.

"Buildings of Class No. 1 (mill buildings) not over 25 ft. to the eave-line shall be designed to resist a horizontal wind-pressure of 15 lb. per sq. ft. on the sides of the building, and the corresponding normal component on the roof according to the Duchemin formula for wind-pressure on inclined surfaces.

"Where buildings are more than 25 ft. to the eave-line, the horizontal pressure shall be taken at 20 lb. per sq. ft., and the corresponding normal component on the roof.

"Only the excess of the wind-stresses obtained by this paragraph over the wind-stresses according to Clause 13 (stresses due to dead and live load) need to be considered. In arriving at this excess the wind included in the total uniform loads designated in Clause 13 shall be assumed at 10 lb. per square foot.

"For combined stresses due to wind and other loads, the above mentioned stresses (working stresses for dead and live loads) may be increased 50%, provided the section thus obtained is not less than that required if wind forces be neglected."

It is my experience in checking over many designs, and observing the sizes of members and connections of buildings which have stood for several years, that the greater number of buildings of the mill-building type which are supposed to be designed for a wind-pressure of 20 to 30 lb. per sq. ft. of exposed surface, would not stand over half this pressure if consistently figured according to the commonly accepted methods of design. The greatest weakness is found in the knee-brace connections to trusses and columns, and in the columns

[2]The difficult point to determine is the exact distribution of the reactions at the foot of the columns resulting from wind, and the amount of 'fixedness' existing in the column, the latter being dependent on the presence or absence of sufficient anchorage.

[3]*Engineering Record*, Vol. 74, No. 24, Dec. 9, 1916.

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themselves. In the case of timber-framed buildings, this comment applies to the actual section of column as a whole; in the case of steel-framed buildings the inconsistence in design may lie in the relative strength of the column section as a whole and the details. For example, an analysis of a steel column built up of four angles laced together, will often show that, while the moment of inertia of the column-section as a whole is sufficient to take the bending due to a 20 or 30 lb. wind, the lacing-bars are far deficient to withstand the compression due to wind shear, as they are usually constructed of 'flats,' with a large ratio of length to radius of gyration.

In the case of a timber-framed building, of moderate dimensions, a rigid adherence to the standard specifications, such as Ketchum's quoted above, will often give results that are out of reason, when compared to buildings that have long given service, and whose strength no one would seriously question. This can best be brought out by a typical example. Consider a timber-framed building of the mill-construction type, with trusses 16 ft. centre to centre, 30-ft. span, and with a height to the eaves of 15 ft., height from floor to foot of knee-brace 11 ft., distance from floor to bottom of trusses 15 ft., and an over-all height of 24 ft. At 20 lb. per sq. ft., the total wind-pressure on one bay is $16 \times 24 \times 20 = 7680$ lb. Assuming the wind-reactions to be equally divided between the windward and leeward columns (the usual assumption in design), the reaction on one post is 3840 lb., and the moment at the foot of the knee-brace is $3840 \times 11 \times 12 = 507{,}000$ lb.-in. Using a maximum fibre-stress of 1800 lb. per sq. in., the required section-modulus of the column is $\frac{507000}{1800} = 282$ in. (It is assumed that the dead load and the direct wind-load will not stress the post over 1000 lb. per sq. in. in addition to the 1800 lb. due to the wind). This section modulus corresponds to a 10 by 14-in. post. Yet a building of this size and type with posts 10 by 14 in., 16 ft. centre to centre carrying a corrugated-iron roof and walls, would be considered a monstrosity, and rightly so. It is true that a smaller post might be used, if the columns are fixed at the base. Assuming that the columns are rigidly fixed at their bases, the wind-pressure producing bending in the posts would then be $19\frac{1}{2} \times 16 \times 20 = 6240$ lb. The reaction producing bending would be 3120 lb., and the column-bending, $3120 \times 5\frac{1}{2} \times 12 = 206{,}000$ lb.-in. The required section-modulus of the timber is $\frac{206000}{1800} = 114$ in., which is furnished by an 8 by 10-in. timber. Even this size of post is too heavy. In addition, it will be found to be difficult to design an anchorage that will develop the required fixing-moment, and which can be depended upon to remain tight under all conditions.

In the first instance taken, the building with columns hinged at the base, the stress in the knee-brace is $\frac{15}{4} \times 3640$ lb. $\times 1.41 = 19{,}000$ lb. In the second case, columns fixed at the base, the knee-brace stress is $\frac{9.5}{4} \times 3120$ lb. $\times 1.41 = 10{,}400$ lb. Both these stresses will require a well designed connection of knee-brace to both column and post. A bolt or two, and a few spikes will not suffice. It must also be remembered that the connection must be designed so that it will be able to withstand both tension and compression.

For a building of the type and size just described, I believe that a wind-pressure of 10 to 15 lb. per sq. ft. of exposed surface is sufficient for the design of the trusses and posts. The girts should be designed for a load of 15 to 20 lb. per sq. ft. of tributary area. The posts should be tied into the foundations, since the dead load coming on the posts is small. I have often found it necessary to provide more concrete in the post-footings than is required from considerations of unit soil-pressure, in order to give rigidity to the building. In such cases, $\frac{5}{16}$ by 3-in., or $\frac{3}{8}$ by 3-in. strap-iron, bolted to the posts, and anchored in the concrete footing will give a certain 'fixedness' to the posts. The necessity of such anchorage can be determined easily: if the anchorage is merely to prevent overturning of the building, the direct wind-load in the column should not be allowed to exceed about 80% of the computed dead load in the column. If the weight of the concrete footing is utilized to give fixedness to the column and thus reduce the wind-bending, it may be found that a considerable mass of concrete is necessary.

In referring to overturning of the building, I have in mind incipient overturning, or a lifting of the windward-post off its base. It is almost inconceivable that the building could overturn as a whole. A 'mind's-eye' picture of the probable action of such a building under a terrific wind will emphasize the enormous strain that would come upon the knee-brace connections, and will bring home the fact that such connections are the most important in the whole structure in resisting lateral forces.

In making the above recommendations for a reduced wind-pressure to be figured on mill-construction buildings, I am considering localities not subject to cyclones or tornadoes. It is my belief, that a carefully designed timber-framed building, with connections intelligently studied, will be perfectly safe under all conditions that may arise on the Pacific Coast, at least, provided that the girts are designed for 20 lb. wind-pressure per sq. ft., and the frame for 15 lb. Indeed, in some places, and for some buildings, I would not hesitate to reduce the foregoing pressures to 15 and 10 lb. respectively. A 15-lb. wind-pressure would be produced by a gale of a velocity of 60 miles per hour, which seldom occurs even for a few minutes.

The corresponding unit-stresses to be employed in connection with the wind-pressures advocated above should not exceed 2000 lb. per sq. in. for combined dead and wind load, including flexural and direct wind-load stresses. Unless the building is of unusual length, the end-walls offer considerable resistance for transferring the wind to the ground, the roof acting as a horizontal or inclined truss delivering the wind-load to the end-walls. For this reason, such walls should be well braced, with diagonal bridging.

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Working Drawings

Not only must the designer of timber-structures be able to compute the necessary sizes of the members, and the details of the connections; he must be able also to present his design clearly to the builder. This statement is not peculiar to timber-framing, yet it needs to be emphasized, especially in this connection. The engineer accustomed only to steel design, and even the engineer versed in reinforced concrete design, is prone to leave much to the detailer, knowing that standard practice will govern many details, and that he will check over such details after the design is completed, before fabrication of the structural steel or the steel reinforcing-bars is begun. As has been stated already in these pages, standard details, in timber design, do not exist. Left without working-details, and given sizes of main members, the carpenter will build a structure. Whether such structure will be safe, depends largely upon the carpenter's experience. A timber cut too short may be spliced with comparative ease, even if not with full safety, and by means of saw, hammer, and a few nails, a makeshift connection that may appear to be of sufficient strength can always be accomplished.

In the preparation of drawings for a timber-framed structure, two conditions present themselves, (1) when the structure is to be built by contract, and (2) when it is to be constructed by day labor or force-account. In the first case, the engineer may require detail drawings to be furnished, just as for a steel-framed structure, such details to be checked and approved by him before any material is bought. For the steel and iron-work, this method may be entirely satisfactory, provided that the contract drawings and specifications show clearly just what is wanted, since such detailing will in all probability be done by an experienced structural draftsman. This is providing that the job is of sufficient magnitude so that the steel and iron-work will be fabricated by a shop of some size. For the timber-work, it will be necessary for the designer practically to detail the job completely, as only in this manner can the desired connections be shown clearly. A case of an all-timber structure where the designer can show a diagrammatic plan, elevation, and sections, giving sizes of members, and main dimensions, and expect a draftsman to draw up satisfactory details is practically an impossibility.

In the second case, where the structure is to be built directly from the designer's plans, with no other details, particular care should be taken to see that every important member and connection is shown clearly. The steel should be detailed accurately and fully, the number and length of all rods, bolts, etc., listed, and all steel should be designated in accordance with a clear system of marking. In this work, one day in the office is worth at least two in the field. There is no better check that can be applied to drawings than to prepare an accurate list of every piece of material in the structure. In fact, I know of no better method to make one realize the convenience, not to say necessity, of fully-detailed drawings, than to be compelled to make a complete detailed estimate of cost. While in the case of small timber-structures, and for some larger ones, it is the custom of the contractor or carpenter to order bolts and other small steel material as he needs them in the course of construction, such a course will not be satisfactory on a large structure. Even on a small job, it is an inefficient and wasteful method.

The engineer will sometimes be called upon to furnish plans and specifications for timber structures in isolated localities, where all material needed for the job must be purchased beforehand, and shipped to the site, and where mistakes in ordering material or in showing details may cause serious delay and expense. For such a condition, I believe that it pays well to mark every bolt and rod, that is to say, all bolts of a certain length and diameter are to be given a special mark, as a letter or group of letters, or a combination of letters and figures, in accordance with some definite system. For example, all bolts in columns may be given the prefix *C*, as *C*-1, *C*-2, etc. Not only should these marks appear in the bolt-list after the particular bolt-size, but the marks should be placed on the bolts on the drawing in the elevation of the column. Further, the bolts should be shipped in bundles of one size and length, bound together, and tagged. This is, perhaps, going outside the domain of strict design, and into the field of detailing and construction, yet it should be a part of the designer's task, in the case under consideration, to detail the work, and to draw his specifications for the contractor furnishing the iron-work so that the field work will be a minimum. This suggestion as to marking applies to all steel of whatever shape. Rods should be tagged, and structural shapes plainly marked by painting, with the corresponding marks at the proper places on the drawings. It is highly desirable to mark the cutting lengths of the important timbers on the drawings; it is much simpler, and better, for the designer, who, at the time, has the structure well in mind, to note the lengths of timbers, than for the carpenter to compute the lengths. Objection might be made to this statement, on the ground that it puts the responsibility for accuracy on the engineer, rather than on the carpenter. For a contract drawing, such a contention may hold; for the detail drawing as required under our present assumption, the argument is unsound. Thorough checking is essential, and such checking should always be given, even at the expense of having the owner annoyed by an apparent needless delay in the completion of the drawings. After the structure is well under way, and the work is progressing smoothly and rapidly, the owner will forget any small delay in getting out the plans and specifications; on the other hand, he will seldom forget a mistake.

In the preparation of drawings for timber-framed structures, there should be a general plan, framing-plans, elevations, cross and longitudinal sections, and details. The exact number of drawings, it is hardly necessary to state, will depend altogether on the kind of structure, and its simplicity or complexity. In general, the plans as opposed to elevations, sections, and details,

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should be to the scale of eight feet to the inch, or, as commonly called, $\frac{1}{8}$-in. scale. In some cases, it may be advisable, for the sake of clearness, to use a larger scale, as $\frac{1}{4}$ in.; and certain small parts of the general plans may need to be re-drawn to a $\frac{1}{2}$-in. scale, in addition to the smaller scale. No matter how many parts of the building may be drawn to a large scale, as $\frac{1}{2}$ in., a complete plan to a $\frac{1}{8}$-in. or $\frac{1}{4}$-in. scale is needed, in order that the entire structure may be seen at a glance. The elevations can usually be shown to a $\frac{1}{8}$-in. scale, and the general cross and longitudinal sections to a $\frac{1}{8}$-in. or $\frac{1}{4}$-in. The details should be at a scale not less than $\frac{1}{2}$-in.

In the case of a frame building of the mill-construction type, taking a typical example, of a building 100 ft. long, and one bay wide, trusses say 40-ft. span, corrugated-iron sides and roof, and floor of timber construction, about 3 ft. off the ground, the following plans will show the work completely:

(1) One sheet, to a $\frac{1}{8}$-in. scale, showing the four elevations, with all window and door openings, the doors and windows being lettered or numbered to correspond with details of same.

(2) Foundation-plan, to a $\frac{1}{8}$-in. scale, showing size and position of piers and wall-footings, with $\frac{1}{4}$-in. or $\frac{1}{2}$-in. details of the individual footings and piers.

(3) Floor-framing plan, to a $\frac{1}{8}$-in. scale, showing sizes of joists and girders and posts, with all dimensions of spacing of same, and centre lines of truss-posts, and first-floor posts.

(4) Roof-framing plan, showing main trusses, with their proper letters, bracing-trusses, bracing, roof-joists, roof-covering.

(5) Cross-section for the building to a $\frac{1}{2}$-in. scale, completely detailed as to roof-joists, trusses, columns, and floor-construction.

(6) Miscellaneous-timber details to a $\frac{1}{2}$-in. scale, as may be necessary.

(7) Details of all fabricated steel to a 1-in. scale.

In general, such scales as $\frac{3}{16}$-in., and $\frac{3}{8}$-in., should be avoided, although no hard and fast rule can be made. An architect employs a $\frac{3}{4}$-in. scale to show details on a contract drawing. It is often convenient, therefore, to use the same scale when preparing structural drawings for an architect; the architect's tracings may be superimposed on the structural drawings, and vice versa. Mistakes of clearances may sometimes be found in this manner. However, on the other hand, there is often an advantage in re-drawing the architect's outlines within which the engineer must confine his work; errors of scale are discovered in this manner. The converse is also true; the architect may find mistakes in the engineer's drawing when he lays it out on the architectural sheets.

It is unwise to furnish a drawing that is badly out of scale, even if it is fully and accurately dimensioned. This holds good for construction in any material, but is especially true in timber construction, as the carpenter is almost sure to scale some timbers. For this reason, considerable erasing, and even re-drawing and re-tracing will be well worth the effort and expense, if, by such extra work, a drawing badly out of scale may be made to scale. Serious errors on the carpenter's or contractor's part may thus be avoided.

Finally, a general and comprehensive note should be placed on all structural drawings. This procedure may not be in accordance with the theory held by many, that written instructions are specifications, and as such, should not appear on the drawings. If this view is held, allow the specification writer to incorporate such instructions to the contractor in his specifications, but be verbose to the extent of repeating the more important points on the drawing in a general note. The specifications, bound separately from the plans, often become separated from them. Notes on a drawing cannot be detached from the details. Finally, it is a curious fact that a note on the drawings carries about twice as much weight with a carpenter as an obscure sentence in the specifications.

General Suggestions for Preparing Structural Plans and Specifications[4]

Unless specifically stated otherwise, the plans to be furnished are to be what are known as 'Contract Drawings.' That is, the drawings and specifications are to show the structure in such detail that the exact amount of all material may be determined without resorting to computations for strength of any member or detail of the structure, but subsequent shop and field details will be required, the same to be checked in a general way by the engineer for strength, but not for accuracy of detail-dimensions.

To this end, there shall be furnished, in general, a foundation-plan, framing-plan, sections, and elevations, and typical details of all connections, sufficiently dimensioned and noted, so that the detailer may understand fully the requirements of the design. The specifications shall state the kind and quality of all material entering into the structure and shall give all other information and requirements that the fabricator and erector of the structure will need in order to produce a workmanlike job.

In the case of building-plans, the scope of such plans may be more specifically stated as follows. There shall be furnished a general ground-plan, foundation-plan, floor-framing plan or plans, depending upon the number of floors, roof-framing plan, typical sections, cross or longitudinal, and details of all important connections.

Scale. The scale for framing-plans shall be $\frac{1}{8}$ in. or $\frac{1}{4}$ in. to 1 ft. The same scale shall be used for elevations and small sections. Larger sections in which it is desired to show connections of members in addition to the general arrangement of structural members, shall be on a scale of $\frac{1}{2}$ in. or $\frac{3}{4}$ in. to 1 ft., preferably the former. Details of steel and iron-work, as shoe-plates, washers, etc., shall be at a scale of not less than $\frac{3}{4}$ in. and preferably to a scale of 1 in. to 1 foot.

[4]See author's note at the end of this article.

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Timber-Framed Buildings of the Mill-Building Type

Under this class will come power-houses, switch and pump-houses, machine-shops, armories, skating-rinks, pavilions, etc.

Roof Loads. For localities where a snow-load cannot occur, the following minimum loads shall be used.

1. Dead Load. The dead load shall consist of the weight of the roof-covering, rafters, purlins, roof-bracing truss, and ceiling, where the latter occurs. The weight of the roof-covering, rafters, and purlins shall be taken as applied at the panel-points of the upper end of the truss. The weight of the roof-truss for light trusses may be considered as concentrated at the upper chord. For roof-trusses, in which the dead weight of

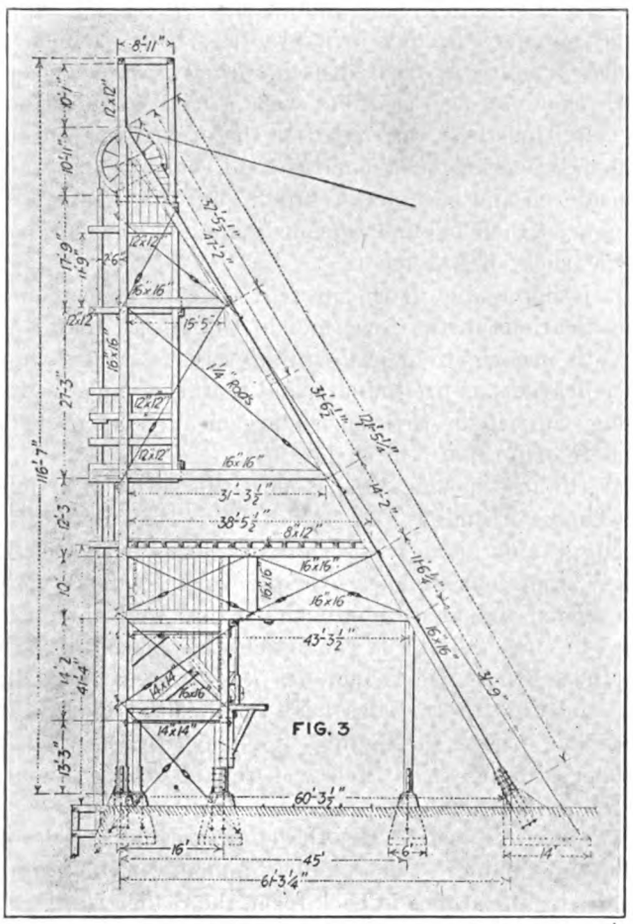

FIG. 82. POORLY DESIGNED HEAD-FRAME.

the roof-truss is over 15% of the total dead and live load supported by the truss, and including the weight of the truss itself, the weight of the truss shall be considered as applied equally at the upper and lower-chord panel-points. The weight of the ceiling, where such occurs, shall be considered as concentrated at the lower chord.

2. Live Load. The live load on the roof shall be taken at 20 lb. per sq. ft. of projected area for rafters and purlins, and the same figure shall be used in computing bending in the top chords of the trusses. The roof-covering shall be designed for a load of not less than 30 lb. per sq. ft. and computations shall be made both for strength and stiffness. The live load on the trusses shall be taken at not less than 15 lb. per sq. ft. of tributary area.

3. Wind Load. The wind load on the roof of buildings not over 25 ft. to the eaves, shall be considered as applied normal to the roof-surface, and the amount of such normal wind shall be computed by Duchemin's formula.

$$p = P\frac{2\sin\Theta}{1+\sin^2\Theta}, \text{ where}$$

p = normal pressure on roof in lb. per sq. ft.
P = 15 lb. per sq. ft.
Θ = angle which the plane of the roof-surface makes with the horizontal.

For buildings over 25 ft. in height to the eaves, P in Duchemin's formula shall be taken at 20 lb. per sq. ft.

Walls. For buildings not over 25 ft. in height to the eaves, the wall-covering and girts or studs shall be designed for a horizontal wind-pressure of not less than 20 lb. per sq. ft., and the columns, when forming a transverse bent with the roof-trusses, shall be designed for a horizontal wind-pressure of 15 lb. per sq. ft. For buildings over 25 ft. in height to the eaves, the above pressures shall be increased 5 lb. per square foot.

All roof-trusses and columns shall be designed for the maximum of the two following conditions.

1. Dead load plus wind load.
2. Dead load plus live load.

Unit Working-Stresses.

DOUGLAS FIR TIMBER (Grade No. 1 Common)

	Lb. per sq. in.
Tension with fibres	1,500
Compression, end-bearing	1,600
Compression across fibres	300
Bending, extreme fibre-stress	1,500
Modulus of elasticity:	
(*a*) For dead load only	1,200,000
(*b*) For live load only	1,600,000
Shearing with grain	150
Longitudinal shear in beam	175
Columns:	
For columns under 15 diameters	1,200
For columns over 15 diameters.....$P = 1600\left(1-\frac{1}{60}\frac{L}{d}\right)$	

where P = unit working-stress in lb. per sq. in for centric loads
L = unsupported length of column in inches
d = least width of column in inches

Steel:	Lb. per sq. in.
Tension	16,000
Shear	10,000
Bearing	20,000

Nails. See Tables II, III, 1V, V, and VI of Article III of this series.

Screws. See Table IX of Article III of this series.

The unit working-stresses as given above may be increased 25% for wind-stresses.

Details of Columns. Columns may be considered as fixed at the ends, where provision can be made for obtaining the condition of fixedness desired. In the case of built-up columns, attention shall be given to the

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detail of fastenings to insure the existence of sufficient fastenings to provide for the shear in the columns on account of wind.

When bending because of wind occurs, the total unit compression on the extreme fibre resulting from dead load, direct or axial wind-load, and wind-bending may be taken at 2000 lb. per sq. in. provided that such column is rigidly supported laterally at the points where such maximum fibre-stress occurs, and that the maximum stress because of a combination of dead and live load alone does not exceed the allowable unit stress as given by the column-formula under 'Unit Working-Stresses,' and also that the maximum unit compression on the extreme fibre at the centre of the column-height because of dead load and wind-load does not exceed the allowable unit stress as given by the column-formula, increased 25%, the term d in the formula to be considered as the depth of the column in the plane of bending.

The maximum ratio of length of timber columns to the least width shall be 60. In computing unit stresses, the area of timber taken out by bolts shall be deducted from the gross area of column-section.

Built-up columns shall be avoided whenever possible. Columns, built of two or more sticks of timber merely bolted together, shall be computed as a combination of several columns, and the strength of each timber computed as a column, independent of the others. Built-up columns shall be considered effective against wind in the plane of the strongest section of the column only, when regarded as a vertical beam.

Details of Trusses. The area of holes for bolts and rods through both compression and tension members of timber shall be deducted to obtain the net section to resist compression and tension. The area taken out of upper chords of timber trusses by butt-blocks of web-members shall not be deducted in computing the size of chord to resist bending because of transverse loading between panel-points, and such chords shall be considered as continuous beams.

All rods in tension shall be of steel. If upset ends are used, such ends shall be upset in a proper machine. No welding shall be allowed. All rods in trusses shall be given an initial tension of 2000 lb. per square inch.

All joints of end or batter posts of trusses with the lower chord shall be provided with shoe-plates, or other suitable connection, sufficient in strength to transfer the horizontal component of the thrust in the batter-post to the lower chord. Such detail shall provide a definite line of action, and such a joint shall be a simple joint, and shall depend for its strength upon only one type of detail.

Author's Note. The suggestions presented herewith are incomplete, as will be seen from even a casual inspection. No values for the strength of bolts and lag-screws are given. With regard to this omission, I have not determined fully the best method of presenting such data, that is, whether by a table or diagram, and to what extent I am justified in exceeding the limits of actual tests. I have been disappointed in not being able to obtain a report of the results obtained by Professor Thomas of Rose Polytechnic Institute on tests of bolted joints, although I have been informed that these tests check with mine closely. The detail specifications here given are for one type of building only, and even for this class are incomplete.

The scope of these articles which have been appearing for some months past has been wider than was at first intended. To my mind, the ideal specifications should cover, in a general way, at least, all classes of timber-framing, since these different classes merge one with the other. For this reason, the specifications should summarize, in concise form, all the material that has preceded, and which has, in many cases, been presented only in a general, and in some cases, a superficial manner. In my own practice, each problem in timber-framing is treated as a special problem General principles are used, but with special modifications, as conditions may warrant. On the other hand, specifications, covering such a large field, must be carefully considered and succinctly stated, guarding against the danger of their being erroneously applied, through lack of clearness of statement.

It is impossible at the present time to present such specifications in the form and of the length that I believe is necessary. I prefer, therefore, to regard these specifications as preliminary and tentative only, and as being subject to revision, enlargement, and probable change of form at a later date.

With these specifications, I close this series of articles on Timber-Framing. As stated above, their extent has been greater than was originally expected. On the other hand, looking back over the work, I can see many omissions, and many points that could well be considered in more detail. If the articles have been of value to those whose work includes design in timber, and especially, if the articles have emphasized to any appreciable degree, the dignity, if I may use the word, of timber-framing, I shall feel well repaid for the labor of their preparation.

[This is the last of Mr. Dewell's series of articles on Timber-Framing. For complete announcement regarding their appearance in book form, the reader is referred to page 8 of our advertising columns.—EDITOR.]

In case-hardening steel articles the best results are obtained with a temperature of 900° C., or 1652° F. The length of time required for the process is between four and six hours, according to the degree of penetration required, the time being taken from the moment that the boxes and contents have acquired the carbonizing temperature.

Concrete highways are found to be safer at night than highways with dark-colored surface. On the dark-surfaced highways there is more chance of running off the road on account of the insufficient contrast between it and the surrounding country.

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Costs of Highway Construction in Oregon

The biennial report of John H. Lewis, State engineer of Oregon, contains considerable cost data on highway construction, from which the following is taken.

Work has been done on seven divisions of highway in Columbia county. The width of roadway was 24 ft., and the maximum grade was 5%. The first division from Westport to Clatskanie, 8.6 miles, cost as follows:

Item	Cost	Cost per mile
Clearing	$5,157.00	$599.65
Grubbing	3,828.75	445.20
Excavation	57,635.86	6,818.12
Culverts, walls, concrete	5,355.97	622.79
Force-account work	26,114.63	3,036.60
Engineering, right-of-way, etc.	12,736.38	1,491.30
Total	$111,828.59	$13,003.32

The second division from Clatskanie to Inglis, 2.6 miles, cost as follows:

Item	Cost	Cost per mile
Clearing	$505.00	$194.23
Grubbing	186.25	71.63
Excavation	10,750.30	4,134.73
Culverts, walls, drains, concrete	1,127.57	433.68
Force account	81.15	31.21
Engineering, right-of-way, incidentals	3,775.67	1,452.18
Total	$16,425.94	$6,317.66

The work on the third and fourth divisions has not been completed. The cost of the fifth division from Delena to the top of Ranier hill was as follows:

Item	Cost	Cost per mile
Clearing	$2,907.50	$528.64
Grubbing	2,023.75	367.95
Excavation	10,381.35	1,887.53
Culverts, drains	230.90	41.98
Force account	8,054.34	1,464.42
Engineering, right-of-way, incidentals	7,492.00	1,362.18
Total	$31,089.84	$5,470.88

The cost of the sixth division from Ranier to Prescott point, 3.1 miles, was as follows:

Item	Cost	Cost per mile
Clearing	$2,589.25	$835.24
Grubbing	1,565.00	504.84
Excavation	58,702.98	18,936.44
Culverts, drains, walls	5,068.61	1,635.04
Force account	11,855.89	3,824.48
Engineering, right-of-way, incidentals	4,623.03	1,491.30
Total	$84,404.76	$27,227.34

The cost of the seventh division from Prescott point to Tide creek, 5.7 miles, was as follows:

Item	Cost	Cost per mile
Clearing	$10,955.00	$1,921.93
Grubbing	1,338.75	234.87
Excavation	58,151.94	10,202.09
Culverts, drains, walls	3,835.34	672.87
Force account	12,087.34	2,120.58
Engineering, right-of-way, incidentals	8,500.41	1,491.30
Total	$94,868.78	$16,643.63

In Washington county, 13,516 ft. or 2.56 miles of old water-bound macadam highway between Hillsboro and Cornelius was surfaced with asphaltic macadam by the penetration method. The old road was scarified with a spiked-wheel ten-ton roller and the road-bed was shaped with a grader and by hand. The average width of the new surfacing was 15½ ft. The crushed rock to an average depth of 3.6 in. was placed on the road, and sprinkled and rolled. After the rock had dried, hot asphalt, grade E, was spread by hand with a dipper, the average amount applied being 1.17 gal. per sq. yd. Rock-screenings were then spread, rolled, and more screenings added until the asphalt ceased to come to the surface. The average amount of screenings was 1 cu. yd. to 44 sq. yd. of surface. The total cost was as follows:

Rock—	Total cost	Cost per sq. yd.
2,326 cu. yd., coarse 525 cu. yd., screenings 2,851 cu. yd. furnished by county and shipped from quarry at Goodin, Oregon. Cost as reported by county judge f.o.b. cars	$2,553.72	$0.1100
Unloading by hand shoveling	453.47	0.0194
Hauling rock, on contract, at 8c. per cu. yd. for first ¼ mile and 3c. for each additional ¼ mile	413.49	0.0177
Spreading, including re-shaping of old macadam	539.14	0.0231
Sprinkling	111.88	0.0048
Rolling	125.25	0.0054
Asphalt, 464 barrels, grade E Road Binder, $15.50 per ton	1,762.43	0.0758
Hauling asphalt	69.38	0.0030
Heating asphalt	105.56	0.0045
Spreading asphalt	140.26	0.0060
Rolling	68.25	0.0029
Miscellaneous expense	58.92	0.0025
Superintendence	201.50	0.0086
Insurance	40.55	0.0017
Timekeeping and supervision	130.27	0.0056
Total	$6,774.07	$0.2910

In Yamhill and Tillamook counties, 4.98 miles of the Yamhill-Nestucca highway has been macadamized. The macadam is 9 ft. wide and there are 2-ft. shoulders on each side, making a 13-ft. road-bed in all. The cost was as follows:

7719 cu. yd. crushed rock at contract price, $1.80 per cu. yd.	$13,894.20
76.25 cu. yd. crushed rock at $0.90 per cu. yd., as per special agreement	68.62
Extra work	1,022.49
Total contract cost	$14,985.31
Culverts	436.12
Administrative engineering and inspection during construction	1,515.64
General charges previous to construction	375.23
Total cost	$17,312.30
Cost per mile	3,476.36

Extra work includes considerable re-grading to straighten alignment, installation of culverts, clearing out drainage ditches, spreading clay binder, sprinkling, etc.

In Polk county, 5890 ft. or 1.11 miles of old gravel-macadam highway near Independence was surfaced with asphaltic concrete. The binder course was 1¾ in. thick, and the surface course, 1 in. The pavement was 16 ft.

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wide with 2½-ft. bituminous-macadam shoulders, making 10,471 sq. yd. pavement and 3272 sq. yd. shoulders in all. The cost was as follows:

Cost of preparing base, applying new rock and rolling, total, $1400.48; per sq. yd., $0.1375.
Cost of pavement—binder course, $6135.39; wearing course, $4159.01; total cost, $10,294.40; per sq. yd., $0.98.
Cost of shoulders—total cost, $862.56; per sq. yd., $0.26.
Total cost of pavement, $12,557.44.
Cost per mile, $11,322.70.
Cost per sq. yd. of finished pavement, 21 ft. in width, $0.91.

In Lane county, 2.31 miles of highway between Latham and Divide was graded and drained. The road-bed is 30 ft. wide, except where it was widened to 40 ft. to secure material necessary for fills. The cost was as follows:

Item	Quantity	Cost
Clearing and grubbing		$ 198.13
Grading, cu. yd.	12,716	4,275.78
18-in. culvert pipe, concrete, lin. ft.	8	81.14
18-in. culvert pipe, corrugated iron, lin. ft.	30	
24-in. culvert pipe, corrugated iron, lin. ft.	120	324.30
36-in. culvert pipe, corrugated iron, lin. ft.	60	296.90
Concrete, cu. yd.	90	1,040.24
Reinforcing steel, lb.	5,879	
Insurance		67.40
Advertising		22.36
Administrative, engineering, timekeeping and miscellaneous expense		520.95
Paid from State fund	$4,553.68	
Paid from county fund	2,273.52	$6,827.20
Right of way, 16.77 acres at $150 (to be paid by county)		2,515.50
Total cost to date		$9,342.70
Cost of construction, exclusive of right of way, per mile		$2,955.50

In Douglas county, 2.4 miles of the Pacific highway between Glendale and Stage Gulch pass was graded and drained. The road-bed was 14 ft. wide and the maximum grade was 5%. The cost was as follows:

Item	Quantity	Cost
Clearing and grubbing, acres	16.4	$1,301.26
Excavation, common, cu. yd.	5,689	
Excavation, intermediate, cu. yd.	11,021	
Excavation, rock, cu. yd.	3,103.9	
Total roadway excavation, cu. yd.	19,813.9	12,203.56
Bridge and culvert excavation (cost included in bridges and culverts), cu. yd.	649.5	
Reinforced concrete culvert (including excavation in rock and reinforcing steel), cu. yd.	19.5	511.18
Plain concrete in head-walls, drop inlets, etc., cu. yd.	22.05	142.35
10-in. vitrified-clay pipe, lin. ft.	194	
12-in. vitrified-clay pipe, lin. ft.	106	
18-in. vitrified-clay pipe, lin. ft.	230	
24-in. vitrified-clay pipe, lin. ft.	90	
12-in. corrugated-iron pipe, lin. ft.	82	
18-in. corrugated-iron pipe, lin. ft.	40	
30-in. corrugated-iron pipe, lin. ft.	50	
36-in. corrugated-iron pipe, lin. ft.	38	
4-in. porous drain-tile, lin. ft.	200	
6-in. porous drain-tile, lin. ft.	160	
Total length drains and culverts, lin. ft.	1,190	1,405.00
Wooden spans, ft. B.M.	20,500	582.66
Total		$16,146.01
Camp construction		841.64
Mess operation		251.71
Blacksmith shop		604.15
Insurance		387.50
Miscellaneous		120.05
Administrative, engineering, inspection, timekeeping, etc.		1,569.99
Total cost		$19,921.05
Cost per mile		8,300.00

In Jackson county, considerable grading and construction of macadam and concrete pavement has been done on the Pacific highway in the Siskiyou mountains. The cost summary is as follows:

Length, 13.4 miles; width of road-bed, 24 ft.

	Amount	Cost per mile
Construction costs up to and including March 31, 1915	$208,660.48	$15,571.67
Construction costs, March 21, 1915, to December 1, 1915	8,353.80	623.32
Total	$217,014.28	$16,195.09
Length, 14.4 miles (Jan. 1, 1916, Dec. 1, 1916).		
Construction (slides, grading, maintenance, ditches, etc.)		
Grading, slides, etc.	$ 4,827.48	$ 335.24
Equipment	265.12	18.41
Engineering, supervision, etc.	1,027.19	71.33
Sub total	$ 6,119.79	$ 424.98
Total construction to date	$223,134.07	$16,620.07

PAVING, 1915

		Cost per sq. yd.
(Two-course concrete; 1.75 miles; 8225 sq. yd.; 8 ft. wide, 6 in. thick).		
Total cost, including gravel shoulders	$ 16,041.59	$1.736

MACADAM, 1915

Two-course

(2.13 miles; 9984 sq. yd.; 1650 cu. yd.; 8 ft. wide, 6 in. thick).		
Administrative, superintendence, engineering and general	$ 889.02	$0.089
Materials	4,005.16	0.401
Labor (sub-grade, hauling, spreading, rolling)	1,658.29	0.166
Total	$ 6,552.47	$0.656

MACADAM, 1916

Three-course

(4.6 miles; 22,584 sq. yd.; 4126 cu. yd.; average 8 ft. wide, 7 in. thick).		
Administrative, superintendence, engineering and general	$ 1,114.51	$0.050
*Materials	6,377.81	0.282
Labor (sub-grade, hauling, spreading, rolling and sprinkling)	4,488.83	0.198
Total	$ 11,981.15	$0.530

*25% of cost ($637.20) of equipment is included in materials; 40% of $793.06 for freight and handling equipment and erecting bunkers included. This equipment will be used the following year.

Fifteen miles of the Dalles-California highway from Bend southerly has been graded by force account. The width of road-bed was 24 ft. and the maximum grade 5%. The cost of construction was as follows:

Item	Amount	Cost
Clearing, acres	65.72	$ 2,631.07
Grubbing, acres	54.27	6,242.00
Excavation, earth, cu. yd.	20,725	5,585.34
Excavation, rock, cu. yd.	923	1,883.59
Road grader work, miles	15.38	2,167.73
Timber bridge (103 lin. ft), feet B.M.	20,309	495.87
12-in. corrugated-iron pipe, lin. ft.	24	321.01
14-in. corrugated-iron pipe, lin. ft.	120	
18-in. corrugated-iron pipe, lin. ft.	90	
Miscellaneous fencing, road crossings, etc.		70.85
Total cost construction		$19,836.34
Engineering, inspection, timekeeping, etc.		430.88
Total cost construction		$19,836.34
Cost per mile		1,329.51
Cost preliminary surveys		2,033.85
Cost per mile		136.62

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Valuation of Public Utilities

The final report of the committee on valuation appointed by the American Society of Civil Engineers appears in a recent number of the *Proceedings* of the Society. The committee was composed of Frederic P. Stearns, chairman, Charles S. Churchill, William G. Raymond, Henry E. Riggs, Jonathon P. Snow, William J. Wilgus, and Leonard Metcalf. The committee also prepared the following abstract, which is about one-twentieth as long as the complete report.

The committee, in its consideration of the subject assigned to it, has been guided by the belief that stress should be laid on fundamental principles and on general methods rather than on details which necessarily vary under different circumstances; that the discussions, unless otherwise stated, should be confined to normal properties; that valuation should have its foundation in fact; that where there are alternative methods equally fair to the parties affected, the one should be selected which is most capable of being carried out effectively under present laws, as defined by the Courts, and which is most desirable for general use in the direction of uniformity; that recognition should be given to the inter-dependence of the various elements which enter into the problem; that while major attention should be given to the ascertainment of the cost of creating the property in question and its business, due consideration should be given intangible values, and that the important item of interest, in this report meaning interest compounded annually, should always be considered.

In the light of this preliminary understanding and of the discussions which ensued, the following conclusions have been reached.

Fundamental Principles of Valuation

The principles and methods must be such that when properly applied the result will be fair to all parties affected and of a nature that will attract to the service of the public, capital necessary for building new properties and for improving and extending old ones.

New Properties. In the valuation of a new property, if the question of a fair return is at stake, the actual investment in the portion devoted to public use, including working capital and development expense, should be taken as the basis for 'fair value'; if the same property just ready for operation is to be valued for public acquisition, the basis of 'fair value' should be the actual cost, including the money value of services and other considerations involved; if the valuation is to be used for capitalization, the result should be attained in the same way as the return base, except that all parts of the property should be included; and if for taxation, whether of a new or old property, the result must accord with the laws of the State, or, where not governed by such laws, should, to make it equitable, be fixed at a sum consistent with the valuation of other property for taxation.

Old Properties Under Continuous Regulation. In the valuation of an old property, operating without competition and from its inception under commission control as to rates and methods of accounting, and assumed to have been entitled to earn sums sufficiently large to provide for all expenses of maintenance, operation, and taxation, depreciation allowances, and a fair return on the 'fair value' of the property, the owner should be compensated in some way for losses that he may have sustained during the early years of operation before the business was developed, either by including in the valuation the sum of the deficiency of earnings in the early years, with interest, or by allowing higher rates of return in subsequent years to offset the early deficiency.

Old Properties Not Under Continuous Regulation. In the valuation of an old property which has not been subject to continuous regulation, not only are the foregoing principles important, but there are many cases in which equity calls for the inclusion of not only the sum representing the sacrifices by the owner but also a further positive or negative sum representing valuable property or rights which may have been acquired or lost by the owner as a result of time or through the failure of the public or the owner to assert their authority, the Courts holding that the present value of the property should be used rather than its cost.

Physical Property to be Included in Valuation

This varies in different cases with the use to which the valuation is to be put and the law governing the case.

Used and Unused Property. In case of rate regulation, only property considered to be devoted to public use should be included, embracing that which is in active use and also that which is properly and reasonably held in reserve to insure the safety, economy, sufficiency, and continuity of service. In valuation for capitalization and public acquisition it is obvious that all the property in question should be included.

Retired or Discarded Property. Plant units that have been definitely abandoned and are not likely again to be used, due to having been worn out in service or by reason of the reconstruction of the property, should be excluded from the valuation and should appear either in a separate schedule of retired or discarded property, or such full statement of the conditions should be made as will definitely fix the status of the units or parts. Temporary works necessarily built in connection with, or required for, the construction of permanent works,

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or for furnishing service to the public at an earlier date than it could be furnished by the permanent works, should be included in the valuation.

Excessive Size or Capacity. No reduction should be made in the valuation on account of excessive size or capacity, except when the excess is so great as to be clearly unreasonable and is the result of not using proper foresight.

Donated Property. Lands or other property voluntarily donated to a public utility should be included when determining the reproduction cost, on the same basis as land and property otherwise acquired.

Leased Property. In the case of leased property, either the property itself or the lease should be valued, as circumstances may dictate.

Title to Property Not Conclusive. Structures on land to which the owner of a public utility has no title should be included in the valuation of the property where the owner has been required by law or necessity to pay their cost, including in the class also property voluntarily donated: and they should be excluded where other public service companies, the public, or the users, other than the owner in question, have been required by law or necessity to pay their cost.

Working-Capital. It is customary to include under the term 'working-capital' the amount of cash, materials, and supplies, provided for use in the plant, but not yet forming a part of it, and other current assets that are essential for the proper maintenance, operation, and administration of a property. There should be included in a valuation an amount of working-capital sufficiently large, not only to meet the usual requirements, but to provide for emergencies.

Securities Owned. Ordinarily, the valuation of property devoted to public use should not include securities owned, or surplus cash not forming a part of working-capital, except in instances where such securities and surplus cash are an offset, in whole or in part, for depreciation deducted from the cost of the property.

Original Cost to Date

As defined by the committee, this is the first cost of the identical property units now in use, including overhead charges. While much of the difficulty of determining original cost as thus defined in some cases may be removed, especially in the case of short-lived property, it is not feasible to obtain a dependable result where the absence of reliable historic data makes necessary a resort to estimates, as in the case of old properties consisting mainly of long-lived items.

Schedule. Generally, it will be found necessary to prepare a schedule in the same way that one would be made for determining the cost of reproduction, many adjustments in the records often being required, even under the most favorable conditions, in order to obtain correct results.

Costs. Unit Costs. When a schedule is necessary, the corresponding costs or unit costs are essential to the completion of the inventory, and where these are unobtainable, as is usually true in the case of property units acquired or created long ago, the ascertainment of the original cost is impossible.

Overhead charges are inadequately reflected in the records, as a rule, and therefore adjustments are required that are largely matters of opinion and speculation, and which, in consequence, make more uncertain the final result thus often destroying its usefulness.

Development Expense. The expense actually incurred in connection with the creation of the business of a property should be included as a part of the original cost to date.

Cost of Reproduction

Theory of Reproduction. Estimates of the cost of reproduction should be based on the assumption that the identical property is to be reproduced, rather than a substitute property; that while apparent present-day conditions that would affect the cost of reproducing the property must be considered in any logical estimate, yet history must also be considered, to determine what is to be reproduced, the conditions under which it is to be reproduced, and how the estimates must be made; that for all those items concerning which there can be no doubt the engineer should use the basis plainly applying, and that for those that are doubtful, or have been questioned, he should present the effect of the use of the different bases clearly, that the determining body may have the data for a wise decision; and that normal present conditions shall determine the prices and methods for doing the work.

Preliminary Work. The first step in estimating the reproduction cost of a property is such a study of the property and its history as will enable the estimator to make a complete list of all items, lay out a proper financial and construction program, and fix proper unit prices to the several items of the schedule, after which the property should be divided into groups of items or units that will lend themselves to the depreciation study and accounting, preferably following some well established classification of accounts.

The field schedules and inventories, suitably recorded on appropriate forms, should be based not only on full and complete surveys and inspections of the visible physical property, but they should also reflect a careful historical search of existing records of original conditions, and other reliable sources of information, bearing on items of material or work which entered into or were incidental to actual existing units, special care being exercised to exclude that which is not capable of definite proof, and to limit the speculative uncertainties as far as possible.

Unit Prices. In determining unit prices a rational sequence of construction should be assumed for the reproduction of a property; and rational assumptions should be made as to the manner of doing the different parts of the work, whether by the forces of the company or by contract. Unit prices based, where pos-

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sible, on the actual cost of doing similar work, in a similar manner, under similar circumstances, should be determined by persons of experience and sound judgment. They should be based on the normal average cost of work for a considerable period, say, 5 or 10 years, in order to give stability to the valuation, so that it may be used for a subsequent term of years. In the case of items that are steadily increasing or decreasing in value, the prices adopted should be normal for the time of the valuation. Full consideration should be given to the time allowed for construction, to climatic conditions, and to the effect of any other significant conditions or limitations upon the cost of the work.

Land Holdings. Separate parcels of land, such as one or two lots, or a tract of not unusual size, not connected with other lands of the utility in a strip or body, and where freedom of choice in selection may be exercised, should be valued on the same basis as other lands in the vicinity, used for general purposes.

Where large tracts have been acquired, composed of a number of separate entire parcels, the history of the transaction should be completely investigated and allowance made in the estimate for costs of vacation of streets, or acquisition of other rights, incident to the use of the property as a whole. Such further allowances should be made, as may seem to be justified by experience, to cover excess costs, over and beyond the normal market-values that existed at the beginning of the project, and which were due to fluctuations of price or other causes beyond control. Normal market-values of similar and near-by property, as of the time of appraisal, should be the basis, with such additions as are warranted by the investigation in each case.

In the consideration of values of lands for rights-of-way for a railroad, an electric railroad, an aqueduct, or other like property, or lands for a water-works or a hydro-electric reservoir, where freedom of choice is restricted and where all the land must be acquired, radically different methods must prevail. In the valuation of this class, a distinction is made between:

(*a*) Lands where the entire tract or parcel is taken and there is no element of severance damages;

(*b*) Lands where only a portion of the tract is taken and where the element of severance damages is present;

and the extent of lands of both classes should be shown.

Historic conditions, where ascertainable, should be given due weight in fixing the extent and character of the severance. All elements of value to the seller, including recognition of all damages to the portions of his property not taken, which would prevail in the case of condemnation of the lands under reproduction, should be considered. A determination of the relation existing between actual recent acquisition costs and the normal market-value of the lands out of which the strip or parcel was taken at the time of acquisition is possible in many cases. It would seem that where such relation can be determined, its use in connection with the normal market-values of these or similar lands at the time of appraisal should establish a reasonable cost of reproduction. The determination of the figure to be used should be based in all cases on full consideration of the present normal market-value of the area of land acquired and of other recent purchases by the same or other companies of similar lands in the vicinity or in districts of like characteristics; the damage to the remaining land, not required, due to severance and all consequential injuries; the amount and character of the costs of acquisition and overhead charges; enhanced prices due to active demand; and any other real items of cost which would be included in case of purchase. But no allowance should be included for special values coming after the acquisition of the property on account of its new use or on account of a greater earning power under the new use, or for any other hypothetical 'value.'

Estimates should be based on prices and values as of the time of appraisal, be they higher or lower than those prevailing at the time of original acquisition. The thing sought in reproduction is the fair cost of acquiring the property as of the date of valuation. The treatment of the valuation of land holdings is not yet thoroughly crystallized; therefore the valuing engineer will do well to confer with counsel upon the interpretation of past Court decisions and the legal principles that are most fairly applicable to the case under review.

Overhead Charges. There are certain expenses called overhead charges, inseparable from the construction of any property, which are a necessary and proper part of its cost, but which are not capable of physical identification after the completion of construction work. These expenses cannot be covered in the estimate of 'Cost of Reproduction' by the application of specific unit prices; from their nature they attach to the whole or to large parts of the property rather than to any particular units.

Among the expenditures that must be provided for and classed as overhead charges are:

(*a*) Cost of promotion;

(*b*) Cost of financing and securing the necessary capital with which to carry out the enterprise;

(*c*) Cost of organization, including the incorporation and organization of the company, securing of franchises, and other like expenditures;

(*d*) Engineering, including the making of the preliminary investigations and plans, plans for the construction of the entire property, the engineering supervision of all construction and other work involved in the development of a property, except such direct supervision as may properly be included in the unit prices of various property units, or as specific charge against some particular schedule or group of units;

(*e*) Administration, including salaries for general officers, agents, accountants, clerks, and other assistants, not included in the engineering and legal departments, and all administration expenses;

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(*f*) Legal, including salaries and expenses of law officials and costs of litigation, which vary between wide limits, depending on the character of the property and its location;

(*g*) Interest during the period of construction, on money borrowed, or on money invested in the property by its owners;

(*h*) Taxes and insurance during construction; and

(*i*) Contingencies, representing expenditures that cannot be foreseen, but which from one cause or another are always of considerable size in the construction or reproduction-cost estimate of any great enterprise.

Depreciation and Appreciation

With a desire to remove the ambiguity and resulting confusion that has attended the use of the term 'depreciation' in connection with valuation, the Committee has considered the subject from three standpoints: (1) the cause, decretion or loss of service-life; (2) the record, accounting depreciation, or the money-allowance made in bookkeeping to offset accruing loss of service-life; and (3) the amount sought, depreciation of valuation or fair depreciation, the sum which should be deducted from original cost to date or from estimated cost of reproduction new, as a step in finding that which the Courts have called 'fair value.'

Decretion. This is the fact of loss of service-life of a physical property, or property unit, or item, regardless of its effect on value or anything else. It may be due to use, or inadequacy, or obsolescence or accident, either singly or in combination in a given plant or plant-unit.

Although, in a well-maintained property, decretion is always present in some degree, yet in some cases this decretion, converted into loss of value, which loss is hereafter called cost of decretion, should not be considered to be a deductible quantity in finding the value of the property—that is, it should not be considered as depreciation of valuation, or fair depreciation. Unfortunately, this has not been entirely understood.

Whether or not, and to what extent, if any, the loss of value due to existing decretion shall be deducted from original cost to date or cost of reproduction new, when finding 'fair value' for any purpose, is the great troublesome problem of depreciation in valuation.

Accounting Depreciation. The fundamentals of the methods of accounting for depreciation are that the owner of a public utility is under obligation to the investors in its securities to maintain the integrity of the investment as a continuing property and to furnish suitable service to the public; that the public is under obligation to the owner to pay a fair price for the service rendered, which should cover all operating expenses, a proper allowance for depreciation and a fair return upon the 'fair value' of the property; and that the return to the investor and the rates to the consumer should be kept reasonably stable and uniform from year to year and should be fair.

The four accounting methods in use for accounting for depreciation, the replacement method, the straight-line method, the compound-interest method (formerly called by the committee the equal-annual-payment method), and the sinking-fund method, yield identical costs when the whole life of a property unit is considered, and any one of them seeming to be the most convenient may be chosen, provided only that under the circumstances it is legal, safe, and fair.

The replacement method is applicable to those short-lived properties or parts of properties, made up of a large number of items, the replacement or retirement of which proceeds after a time with fair regularity and causes no troublesome variations in return or service rates; the straight-line method applies to any property units having more than a year of service-life, which are assumed to depreciate uniformly from the beginning to the end of service-life; the compound-interest and sinking-fund methods apply to property units the depreciation of which is assumed to progress at the same rate as a sinking fund grows from an annuity, accumulating at compound interest.

In addition to these four methods there is the unit-cost method, eminently sound in theory but not readily applicable to accounting purposes, which is based on the conception that the value of a plant unit should be decreased from year to year to such an extent that the cost per unit of output or service, taking into account all annual charges for interest, depreciation, repairs, cost of operating, etc., should be constant during each year of the estimated service life of the unit.

The great discrepancy in the growth of depreciation of long-lived units under the straight-line and compound-interest theories should be carefully noted when determining which method to use.

This report is particularly concerned with depreciation accounting as it relates to valuation, and the determination of the depreciation of valuation. It would seem to be fair in any given case to give the method of accounting used by the utility in setting up depreciation allowances its proper effect in determining deductible depreciation or the depreciation of valuation.

Depreciation of Valuation on Accounting Methods and Regulations. Finding the cost of decretion, here defined as the loss of service-life of an item converted into loss of value, is a step in the determination of depreciation, but whether and to what extent, if at all, the estimate thus found shall be treated as depreciation of valuation may be, and very probably will be, dependent, at least in part, on the methods of accounting for depreciation and the character of regulation that have prevailed.

Depreciation of Valuation Under Replacement Method. If by order or sanction of a regulating body, or by long-continued proper custom under no regulation, a property, as for instance a railroad, has been maintained in normal working condition, necessarily less than new in some or all of its parts, by the replacement method, and at any given date is being valued for any

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public purpose and at that date shows normal condition, all its several parts being in as good condition as could be expected, the accounts showing that those amounts have been expended in renewals that were necessary to keep the property in normal working condition, and the fact appearing that no expenditure reasonably to be expected could put the property in better than the normal condition in which it is found, and that no unusually large expenditure is presently to be necessary for this purpose, then, in spite of the fact that there is an existing decretion in its several parts, there should be found no depreciation of valuation. Under the method of accounting, the public has not paid, and could not pay, for the accrued depreciation, and under this condition its accrued obligation to pay should be considered an asset of the company-owner.

If parts of the property are maintained under the replacement method and part by some proper allowance method, except as noted below, then depreciation of valuation should be found with respect to those parts maintained under the allowance method, but this depreciation of specific physical units will be made good in whole or in part by existing funds or properly purchased with allowances, either or both of which will be included in the valuation as they are found.

If, in the judgment of the valuing engineer, the replacement method may not be used with propriety for a given property, either because not in accordance with law, or because the method is not adapted to the property, then, whether or not the property has been maintained in the past under this method, the valuing engineer should estimate depreciation of valuation in the amount of the cost of the decretion he finds. There can be no certainty that the property will be properly maintained in the future.

When a comparatively new property, other than a railroad, is to be valued, and it has not been under any regulation that has affected its accounting method, the law as laid down in the Knoxville decision would seem to make it necessary to find depreciation of valuation in amount equal to the cost of decretion found for all items, whether or not maintained by the replacement method. The committee, however, believes that this may work hardship and injustice in some instances, and suggests that in such cases the facts be reported with such recommendations as to equity, as may seem fair to the engineer.

Depreciation of Valuation Under Allowance Methods. If either the straight-line, compound-interest, or sinking-fund method has been used in computing depreciation, and the method of accounting for it has been prescribed by a regulating body or voluntarily followed by a company owner from the beginning, the same theory, so far as it applies to the property in question, should be used for estimating the cost of decretion; and the entire cost so found, lessened by any accumulated depreciation fund, will appear as depreciation of valuation, unless the sinking-fund method of accounting has been used. In the latter case, if the valuation has to do with the reasonableness of the return and the accounting is to go on as before, apparently existing depreciation would not be depreciation of valuation, and therefore would not be deductible; but if the valuation has to do with condemnation or purchase, then, as in other cases, the apparently existing depreciation is depreciation of valuation, and the owner should receive the depreciated value of the physical property and the existing fund.

Effect of Regulation on Depreciation of Valuation. Regulation which determines the method of accounting will in part determine the amount of depreciation of valuation when finding 'fair value,' because it determines the method by which the public shall pay for the loss of service-life. If the regulating body has prescribed the replacement method for the whole period that units have been in existence, then, although depreciation may exist, it is not depreciation of valuation, because, under the method of accounting, the public has not paid, and could not pay, for the accruing depreciation, and is still under obligation to pay for it.

Methods of accounting in force at the present time which make proper provision for the accruing depreciation should not have full weight, if, in previous years during the life of the property-units, other methods were in use which did not make provision for such depreciation. The amount of depreciation of valuation in such cases should be equivalent to the accumulated contributions of the public for depreciation allowances under the various methods of accounting which have affected the property unit from time to time. The public is still under obligation to make good that part of the loss of service-life not yet adjusted, and this obligation should be considered to be as much the property of the company usable to offset accrued depreciation as renewal funds or property actually in existence.

Whether or not this reasoning will stand in any case is for the Court to determine. Valuing engineers and accountants should report what they find as to the actual cost of decretion, and the sums that have been received to offset such cost, under the methods prescribed by the regulating body from time to time. They may give their opinions as to the amount of depreciation that should be deducted from cost to find cost less depreciation as an element in the quantity known as 'fair value.'

If regulation has not fixed accounting methods, but has limited the earnings, it should be permissible to inquire whether the limited earnings have been sufficient to pay operating expense, depreciation, and fair return. If so, depreciation found should be considered depreciation of valuation to the extent warranted by the accounting methods lawfully or properly followed; if not, a question arises. It is remembered that the duty of the company-owner is first to maintain the property 'before coming to the question of profit at all,' and that it is the duty of the regulating body to see that rates are such as to permit the company-owner to earn operating expense, depreciation, and fair return. If the

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regulating body has made sufficient earnings impossible, is it still the duty of the company-owner to maintain the property before paying fair return to its security holders? If it is, depreciation of valuation should be found in the amount of the total cost of decretion or so far as warranted by the accounting methods followed. If not, depreciation found should not be considered depreciation of valuation except to the extent covered by earnings after deducting operating expense and fair return. This is a matter of equity to be determined by a Court. If under regulation the property is a losing venture, it is not included in the class of properties now being considered. In any event the depreciation existing should be found and reported, together with all pertinent facts, that the Court may determine the equities in the case.

Conclusion Upon Depreciation. The valuing engineer should bear in mind that when a company-owner has invested a reasonable sum in a property for public service, it should receive, but is not guaranteed, a fair return on its investment, so long as the money remains in the property, either as property, or funds, or accrued public obligation to pay. Therefore, so long as the company-owner keeps a sum equivalent to the total investment at work for the public, either as property serving the public, or funds held in reserve for such property, no policy should be followed in estimating depreciation that will reduce the property to a value less than the investment, or, when using cost of reproduction less depreciation, as a basis of 'fair value,' to a value less that the cost of reproduction of that part of the property estimated to have been created with company funds, acquired by gift, or in any way not the result of public contributions to cover depreciation.

Appreciation. Appreciation, largely the result of solidification, seasoning, and adaptation, represents the improvement in quality and usefulness of certain parts of the physical properties of a railroad or other public-utility property, and it results from the lapse of time, from work not specifically charged to capital account, from maintenance, from use, etc., and covers items, not represented either by the quantities or unit prices, that are determined in connection with a valuation.

There should be no general setting off of appreciation against depreciation, but appreciation should be determined independently from depreciation. Care must be taken that items of labor and expense included in the estimate are not duplicated in development expense.

Development Expense

In the production of a normal going-property, development expense, almost invariably, is an unavoidable real cost, and is measured by the difference between the amount which the company is entitled to earn in the early years and the amount which it actually does earn. The portion of this expense incurred in bringing the property to its present state of operating efficiency may be included in the cost of construction, and the rest is the cost of acquiring business.

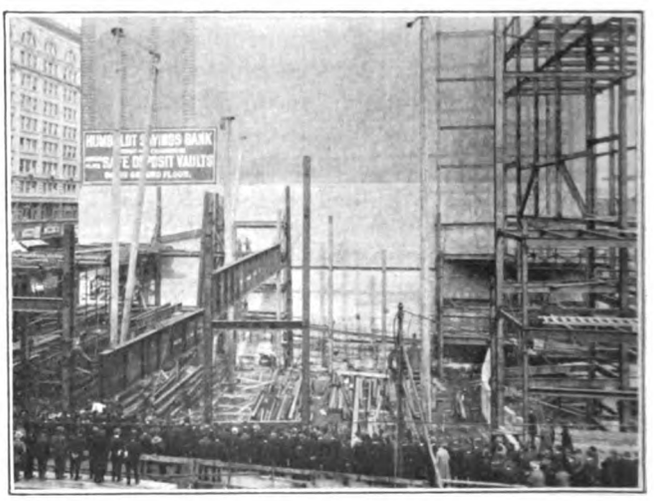
Intangible Value

The intangible value that pertains to a property and should be given due weight in the ascertainment of 'fair value' is the difference between the tangible value—that is to say, proper cost including development expense, less depreciation of valuation—and exchange value, in which is reflected existing and potential dependable income and beneficial results. It embraces going value, in which is merged good will, franchise value, efficiency, favorable business arrangements and design; and it also includes other elements, such as leases, easements, water-rights, traffic and operative agreements, strategic position and advantages, and other privileges.

LARGEST STEEL GIRDERS IN A PACIFIC COAST BUILDING

By J. J. ROSENTHAL*

Two plate girders, 8½ by 88 ft., each weighing 35 tons, the largest assembled girders ever employed in a building on the Pacific Coast, were erected recently by the Dean Construction Co. at the California theatre, Fourth and Market streets, San Francisco. The girders supporting the balcony were lifted by two wooden guy-derricks specially designed for this work, to a height



PLACING THE GIRDERS.

of 36½ ft. in 12 minutes. The derricks were made of 24 by 24-in. Oregon pine timber. The masts were 90 ft. and the booms 85 ft. long. Each mast was anchored by ten 1¼-in. cables to concrete piers. Two cast-steel dogs, each weighing 250 lb., and fastened to seven 1-in. steel cables composed of six strands of 19 wires each, were used to clamp and lift the girders and to hold them in position until bolted to the 14 by 14-in. columns with drift-pins. These pins were then replaced one by one by the ⅞-in. rivets, 78 being used at each end. J. J. Rosenthal, construction engineer of the Safety Department of the Industrial Accident Commission of California, represented the Commission during the work.

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The City-Manager Plan*

By THOMAS H. REED†

Let us survey the history of municipal government in the United States since the American Revolution. We find first a form of municipal government modeled on that of the United States, with a mayor, corresponding to the President, a two-chamber council, corresponding to the two houses of Congress, and with the devices of executive veto and legislative confirmation of executive appointments, which had been applied by the fathers to our Federal government. This form of municipal government brought bad results because it was impossible to pin responsibility for the bad conduct of affairs upon any one; mayor, aldermen, and councilmen engaged constantly in the great pastime of 'passing the buck.' The evil features of this system were further augmented by the addition of numerous independent elective officers, each in charge of an important department of the government. All this complication of governmental machinery serves to create shadows or dark places in which political crime could be committed.

In recent years, three methods of escape have been successively evolved. The first of these is the all-powerful mayor type of government. A single elective officer is entrusted, as in Boston, with practically all the powers of government, and, for his term of office, is virtually a municipal dictator. Personally, I do not approve of elective dictatorship in our National, State, or municipal government. The mayor under this plan is practically irresponsible during his term. No matter what mistakes he makes or what personal vagaries he may display he still retains his power and authority. The recall has been demonstrated to be a device that will be used only in the extremest cases and cannot be counted upon as a steady and efficient check upon an executive officer.

The second method of escape from complicated irresponsible government is the commission form, which has been adopted in many cities. It concentrates all the powers of government in the hands of a small board, each of whom is expected to conduct the affairs of a department of administration. It is certainly an improvement over the forms that preceded it, but it has demonstrated certain defects in practice. In the first place it combines legislative and executive functions in the same individual. In other words, the members of the commission must be at once representatives and administrators. A representative should reflect the opinions of the constitutents, he should be an average citizen. The administrator should be a person trained and qualified for the special task he has to perform. The representative should be a layman, the administrator an expert. You cannot get experts by the method of popular election except accidentally. The man who secures a popular election has to have certain graces which endear him to the public but which have no necessary connection with administrative capacity. Furthermore, in the commission form of government you do not get intelligent criticism of the conduct of the several departments. No commissioner desires to stir up public criticism of himself by starting to criticize one of his colleagues.

The last of the three means of escape is the manager-plan. This gives you a single head for the executive branch of the government. American experience has demonstrated that we need a single head in order to secure success. The manager is, furthermore, constantly responsible to a city council, which may dismiss him at any time. He bears the same relation to the city council as the manager of a corporation bears to its board of directors. Being appointed by the council or the board of directors there is a chance of securing a better man than can ordinarily be secured by popular election. The manager, at least, will be some one who is interested in municipal government and has some qualification for administrative work.

The city-manager plan is succeeding in practice. There are people who criticize it on the ground that municipal government is not a business. It is a business; it differs from private business only in its aim and in the standards by which its success is measured. In private business you have a standard in the money-dividends secured. In a municipal government your dividends are of a social character, and there is sometimes room for difference of opinion as to the worth of the results achieved. The processes of achieving results, however, are practically the same as in private business. There is the same reason for efficiency, for getting one hundred cents of value for every dollar that is spent. The manager form has been tried in Dayton now for over three years and the results are electrifying. It is going to work out in San Jose. If its success for a moment appears doubtful, you must charge it to some fault of the management. In every community you will find a certain class against it, whose opposition is perhaps its best endorsement. This element is the 'political element,' that small group of people who have been playing the game of local politics and whom the manager-plan puts out of business. The business and professional men, however, the really significant men in the community, are almost always supporters of the manager-plan of government.

*Part of address delivered at the State Convention of Commercial Secretaries, Sacramento, California.

†City manager, San Jose, California.

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Activated-Sludge Plant for Sewage-Disposal at Houston, Texas*

By E. E. SANDS†

During the last few years a new method of sewage disposal has been studied by investigators in the United States, England, and Canada. This method, known as the 'activated-sludge process,' can be understood more easily if the original experiments leading up to the discovery of the process are outlined. For many years investigators endeavored to oxidize sewage by forcing air through it. Generally these experiments were failures for the reason that the attempt was made to oxidize the sewage by direct application of air to organic matter at normal temperatures. Later investigations have shown that such oxidation can be accomplished only by bacterial action. One investigator, however, after aerating a bottle of sewage for several days, found that when the air was shut off after a long period of aeration, the suspended matter in the sewage settled to the bottom rapidly, the only other visible change being a slight alteration in color. He then drew off the clear liquor, added a fresh supply of sewage, and continued the aeration. This time it was found that it was not necessary to aerate the sewage for as long a time as before, and that when the air was finally shut off, the suspended matter settled to the bottom quickly, the liquor in the upper part of the bottle remaining odorless and colorless. After drawing off the supernatant liquid, a fresh supply of sewage was added. With each addition of sewage the amount of suspended matter in the bottle gradually increased, and as its volume and the length of time it had been aerated increased, it was found that this suspended organic matter assumed an entirely different character. Instead of raw organic solids, there were colonies of aerobic bacteria. This organic matter, which was called 'activated sludge,' became itself a purifying agency and took the place of the filter-medium.

Various investigators took hold of this problem and attempted to design a system for operation on a large scale. Designs were prepared for both fill-and-draw and continuous-flow tanks. A series of experiments were conducted at Houston, Texas, on both a continuous-flow and a fill-and-draw tank. In order to use standard blowers, a tank 10 ft. deep was used. The amount of sludge to be mixed with the sewage while it is being treated may be between 20 and 30%. Air should be supplied at the rate of $\frac{1}{4}$ cu. ft. per minute. It can best be supplied through porous plates, 12 in. square, made out of a material called 'Filtros.'

When the design is such that one plate supplies not more than 12 sq. ft. of tank-surface, it is found that a clear and satisfactory effluent can be secured after one hour of aeration, but if the flow of air is stopped, the clear liquid drawn off, and new sewage added each hour, the sludge will not have secured sufficient aeration to activate it thoroughly. Consequently the plan we have adopted at Houston is to aerate the mixture of raw sewage and sludge for one hour and fifty minutes. The sewage is then run into settling-tanks where it is allowed to settle for forty-five minutes. The sludge that settles to the bottom is pumped out of the settling-tanks by air-lifts and put into tanks where it is re-aerated for two hours and forty minutes longer, after which time it is in proper condition to be mixed with the fresh sewage received at the plant. The record of a small fill and draw plant obtained at the Houston experimental plant is shown in Table I.

Houston has a population estimated at 140,000. Running in a general east and west direction through the city is the Buffalo river, with a bottom width of 80 ft., and which is maintained by the city at a depth of 8 ft. for light-draft vessels. The drainage-area of Buffalo river is a little more than 300 square miles, so that for long periods during the summer months there is no perceptible flow in the channel. Consequently the sewage from the city of Houston has polluted the waters until they are dark in color. The gases arising from the surface are offensive. The topography at Houston is such that all sewage must be pumped once and part of it twice. With the exception of a narrow valley along the river, the remainder of the city and the surrounding territory is flat, the lowest part being 35 and the highest 50 ft. above sea-level. Most of the city lies between an elevation of 40 and 45 ft. The average rate of flow per person is 85 gal. per day; the maximum rate being 104, and the minimum 59. All the sanitary sewers in the city are on a flat grade. The sewage is stale by the time it reaches the pumping-plant. Storm-water is handled by a separate system.

On account of the construction of large mains and collecting systems, some time ago it was necessary to build two disposal-plants, one known as the North Side plant and the other as the South Side plant. The sewage that will flow to the former is received at a pumping-station on the north side of the river and close to the geographical centre of the city. At this point we have installed coarse screens and a grit-chamber. After flowing through the grit-chamber, the sewage is raised by three centrifugal pumps, each having a capacity of 4100 gal. per minute. The lift is 22 ft. From the upper end of the discharge-pipe, the sewage will flow by gravity 14,000 ft. to the North Side disposal-plant. In the south-eastern part of the city there is another pumping-plant.

*Abstract of article appearing in *The Wisconsin Engineer.*
†City Engineer, Houston, Texas.

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TABLE I. RECORD OF PERFORMANCE OF EXPERIMENTAL PLANT

	Crude	1 hour		2 hours		3 hours		4 hours	
	Parts per million	Parts per million	Removal, %	Parts per million	Removal, %	Parts per million	Removal, %	Parts per million	Removal, %
Total organic nitrogen	5.5	2.0	64	1.9	65	1.87	66	1.8	67
Free ammonia	6.32	2.5	60	1.44	82	0.63	90	0.32	95
Total organic matter	299	137	40	134	41	134	41	129	44
Oxygen consumed	139	18	87	17	88	15	89	14	90
Dissolved oxygen consumed	103	3	97	2	98	2	98	2	98
Suspended matter	253	5	98	5	98	5	98	4	98
Nitrites and nitrates	Trace	4	..	8	..	10	..	11	..
	Per cc.	Per cc.		Per cc.		Per cc.		Per cc.	
Bacteria	2,800,000	176,000	93.7	118,000	95.8	117,000	95.8	116,500	

Percentage of sludge for operation, 25 to 30%.
Tank depth, 7 ft. 6 in.
Free air per minute, 3.06 cu. ft.
Area of water-surface, 12.25 sq. ft.
Free air per minute per square foot of surface, 0.25 cu. ft.
Raw sewage at each filling, 420 gal.
Free air per gallon sewage treated per hour, 0.437 cu. ft.
Tank surface per square foot 'Filtros' plates, 12.25 sq. ft.
Number of operations for one filling, 4.

The North Side disposal-plant will contain four and the South Side plant two units. Each unit is capable of handling the sewage for 37,100 persons, or an average flow of 2190 gal. per minute. Each aerating-tank is 18 ft. wide and 280 ft. long. After flowing through these tanks, the sewage will flow across a settling-tank. The sludge will then be returned through a re-aerating-tank 9 ft. wide and 280 ft. long. The clear effluent will be discharged into the river without further treatment. As the water in the river is not used for domestic purposes, sterilization is unnecessary.

The mechanical equipment at the North Side plant consists of three Sturtevant high-pressure blowers, each capable of delivering 3750 cu. ft. of air per minute at a pressure of 5¼ lb. Two of these blowers are sufficient for the operation of the plant. One blower is driven by a constant-speed 150-hp. motor, and the second by a multiple-speed motor of equal capacity. The third is driven by a 150-hp. oil-engine. The power-house is equipped with a crane to be used for the repair and handling of machinery and also with louvres and muslin screens for filtering the air. The South Side plant is similar to the one on the north side, except that it contains two instead of three blowers, one driven by a constant-speed motor, and the other by a multiple-speed motor. Power is purchased at from one to one and two-tenths cents per kilowatt-hour, depending upon the monthly demand. In order to get this low rate the city guarantees a 90% load-factor, the object of installing the oil-engine being to control this factor. If for any reason it becomes necessary to operate an additional motor in one of the pumping-plants or to supply more air at either disposal-plant this can be accomplished by starting the oil-engine, shutting down one motor at the North Side plant, and utilizing the current thus saved at any other point desired.

The particular advantages of this type of disposal-plant may be enumerated as follows:

(1) It can be constructed in any part of a city on a comparatively small area of ground. (2) There are no nuisances around the plant, that is, no objectionable odors, swarms of flies, mosquitoes, or other insects. (3) The plants can be constructed for about $20,000 per million gallons capacity per day, which is about half the amount required for the construction of a first-class Imhoff-tank and sprinkling-filter plant. (4) As compared with the use of sprinkling filters, a saving of from 10 to 14 ft. of head results from the use of this process. (5) The revenue from the sale of fertilizer goes toward the cost of operating the plants. (6) Because the removal of suspended matter is greater than by other processes, the effluent from the plant is clear and sparkling.

The cost of operating such a plant as this will be relatively large, probably nine or ten dollars per million gallons treated, until the plant is running at its full capacity, when this cost should be reduced to five or six dollars per million gallons. The net revenue from the utilization of the sludge should be approximately $3 per million gallons.

Overhead expense in the construction of recent improvements of the irrigation and drainage systems of the Modesto, California, irrigation district was as follows: on the upper works, the expenditure was $470,799 and the overhead for engineering, inspection, and advertising was 4¾%; on the laterals, the expenditure was $86,154 and the overhead, 9¼%; on the drainage work, the expenditure was $44,435 and the overhead 12¼%; and on the entire work the expenditure was $601,388 and the overhead was 5.83%. These figures are taken from a report by F. C. Herrmann, chief engineer for the district.

Topographic surveys of 19,230 square miles were made by the U. S. Geological Survey during the fiscal year ended June 30, 1916. In addition 3486 square miles was re-surveyed, making a total of 22,716 square miles mapped during the year. The total area surveyed to date in the United States is 1,237,520 square miles, or 40.9% of the area of the entire country.

Alcohol added to the water employed for slaking plaster-of-paris increases the time of setting and decreases the degree of heat that may be evolved in the reaction.

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Costs of Oxy-Acetylene Cutting and Welding

The following tables of costs are taken from *National Bulletin* No. 26, issued by the National Tube Co., and based on actual experience. Cost of making butt-welds in pipe, with labor at $0.42 per hour, oxygen and acetylene at $0.02 per cu. ft., and welding wire at $0.10, is as follows:

Size of Pipe	Labor	Oxygen, Cu. Ft.	Acetylene, Cu. Ft.	Wire	Thickness of Pipe	Tip No.	Gas Pressures Oxygen	Gas Pressures Acetylene	Total Cost
4-in.	6 min.	2.84	2.49	5 oz.	15-64 in.	6	12 lb.	6 lb.	$0.1819
6-in.	12 min.	5.68	4.98	8 oz.	9-32 in.	6	12 lb.	6 lb.	0.3472
8-in.	16 min.	7.58	6.65	12 oz.	5-16 in.	6	12 lb.	6 lb.	0.4766
10-in.	18 min.	8.53	7.48	16 oz.	5-16 in.	6	12 lb.	6 lb.	0.5462
12-in.	26 min.	12.32	10.81	20 oz.	21-64 in.	6	12 lb.	6 lb.	0.7746
16-in.	42 min.	33.18	29.40	32 oz.	3-8 in.	8	16 lb.	6 lb.	1.7556

The cost of cutting pipe with the same prices for labor and gases is as follows:

Size of Pipe	Labor	Oxygen, Cu. Ft.	Acetylene, Cu. Ft.	Thickness of Pipe	Tip No.	Gas Pressures Oxygen	Gas Pressures Acetylene	Cost
4-in.	0.625 min.	0.781	0.125	15-64 in.	2	20 lb.	3 lb.	$0.0224
6-in.	0.87 min.	1.087	0.174	9-32 in.	2	20 lb.	3 lb.	0.0313
8-in.	1.5 min.	1.775	0.3	5-16 in.	2	20 lb.	3 lb.	0.0520
10-in.	1.77 min.	2.118	0.355	5-16 in.	2	20 lb.	3 lb.	0.0618
12-in.	2.1 min.	2.625	0.42	21-64 in.	2	20 lb.	3 lb.	0.0756
16-in.	3.62 min.	4.531	0.725	3-8 in.	2	20 lb.	3 lb.	0.1304

Costs of various cutting operations, with labor at $0.46 per hour and gases at $0.02 per cu. ft., are summarized as follows:

Hand Cutting	No. of Cuts	Labor	Oxygen	Acetylene	Total Cost	Cost per Cut
6-in. I-beams	20	75 min.	28 cu. ft.	10 cu. ft.	$1.33	$0.0665
8-in. I-beams	4	6 min.	8 cu. ft	2 cu. ft.	0.25	0.0625
12-in. I-beams	4	8 min.	16 cu. ft.	4 cu. ft.	0.47	0.1175
15-in. I-beams	10	45 min.	40 cu. ft.	10 cu. ft.	1.35	0.1350
15-in. I-beams	1	83 min.	3 cu. ft.	1 cu. ft.	0.092	0.092
5-in. T-rails	20	75 min.	37 cu. ft.	12 cu. ft.	1.55	0.0775
8-in. T-rails	4	10 min.	20 cu. ft.	6 cu. ft.	0.60	0.15
9-in. street-car rails	10	45 min.	40 cu. ft.	10 cu. ft.	1.35	0.135
12-in. Lackawanna piling	88	570 min.	350 cu. ft.	60 cu. ft.	12.57	0.143
1/16-in. boiler plate	40 ft.	60 min.	20 cu. ft.	2 cu. ft.	0.90	0.0225 per ft.
1/4-in. boiler plate	55 ft.	180 min.	130 cu. ft.	40 cu. ft.	4.72	0.086 per ft.
1-in. boiler plate	80 ft.	150 min.	250 cu. ft.	56 cu. ft.	7.27	0.091 per ft.
3/4-in. web of rail	33 ft.	50 min.	90 cu. ft.	13 cu. ft.	2.45	0.074 per ft.

An arc of primary triangulation extending from northern Utah north-westerly to the Columbia river, and thence westerly to Portland, 630 miles in all, has recently been completed by the United States Coast and Geodetic Survey. Motor trucks were used for the first time on such surveys, the trucks carrying the party and outfit as far up each peak as possible, and the outfit being carried to the summit by horses or by members of the party. The longest distance observed was 134 miles, between a peak in northern Utah and one in southern Idaho. Most of the observations were made at night, acetylene-lamps being used.

Automobiles probably handle a larger amount of passenger traffic than railroads at the present time. There are about 3,000,000 passenger-automobiles in the country. A conservative estimate of the average distance covered per year is 6000 miles per car. Assuming the average load for all trips at three passengers, the total number of passenger-miles per year is 54,000,000,000. The traffic of the railroads is now 35,000,000,000. If an average load of two passengers per car is assumed, the total traffic is still slightly larger than that of the railroads.

Spun glass as an insulating material for steam-pipes is being used in Germany. It is lighter than any other insulating material, even than cork, and it is to be preferred to other materials since it is not affected by vibration, high temperature, water, steam, or acids, and does not deteriorate through age. The material consists of fine glass threads about 0.002 in. diam. Rings of asbestos are placed around the pipe at intervals. Between the rings the spun glass is wound loosely about the pipe. The whole is then enclosed with asbestos braid and sailcloth and painted with tar or oil-paint.

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Qualifications for Success in the Engineering Profession*

By W. A. CATTELL†

The most essential qualification for success in engineering, as in any other profession, is character. Honesty, integrity, and singleness of purpose are conceded universally to be the foundation upon which real and permanent success in any calling must be based. The engineer, however, is subject to some peculiar and insidious temptations, and if he is to be really successful, must develop a strength of character and a quality of honesty not always so important in other professions. For instance, it is considered quite permissible for the lawyer to espouse the cause of a client and endeavor to win for him an advantage at the expense of his client's opponent, the very nature of his employment frequently demands that he should do so, but this the engineer cannot do. He must, of course, conserve the interests of his clients and endeavor to secure for them the greatest efficiency of performance and the highest possible earning power for the capital that they invest under his direction, but he must cultivate a strictly judicial attitude and he must have the courage of his convictions in dealing with his clients. He must point out to them clearly what is essentially for their best interests, even though it may result in diminished fees, or possibly the loss of some profitable engagement. It sometimes happens that projects that ultimately result in failure are undertaken because the engineer did not have the courage to tell his clients what the entire cost would be, for fear of their abandoning the project altogether.

In dealing with contractors it is not permissible for the engineer to seek to save money for his clients at the contractor's expense. It is his duty to see that the contractor does his work honestly and thoroughly, but it is also his duty to see that the contractor is justly treated and properly compensated. In disputes between client and contractor it is the province of the engineer to act as arbitrator rather than advocate.

The engineer must therefore develop a high degree of intellectual honesty. It is not sufficient for him to be honest in the handling of money, but he must also be honest with himself, with his clients, with contractors, and with the public. To do this he must have a clear perception of the ultimate effect of his every act and recommendation.

The engineer, too, must guard against the temptation to the more subtle forms of dishonesty to which men in many other professions are also peculiarly subjected. Many a young engineer who thought himself strictly honest in all of his dealings, and who would indignantly reject any offer of compensation for dereliction, has allowed himself to be swerved from the path of rectitude, or at least influenced in his decisions, by the prospect of more remunerative employment or social preferment, with which unscrupulous contractors have sought to bribe him. In the course of litigation in which the engineer frequently finds himself either a willing or an unwilling expert witness, he must be careful that in the heat of controversy or under the stress of a gruelling cross-examination by an opposing attorney, he does not exaggerate conditions or mis-state facts. The temptation to do this is often strong.

The giving of testimony before Courts and Commissions as to the cost of value of public-utility properties has, within the past few years, furnished a considerable amount of employment for engineers, particularly in California. In such cases the engineer must be careful not to allow himself to take the place of the lawyer and become a special advocate for his client, or to make a higher or lower valuation than his best judgment indicates to him to be correct, in the belief that the engineers employed by the opposing side will make a valuation, high or low, in the opposite direction, and that the findings of the Court or Commission will be a compromise between the two, resulting in substantial justice to his clients.

The second essential qualification for success in engineering is industry. Here again, you may say you know that a man must work hard to succeed in any profession. This is true, but I believe the engineer must work harder than the lawyer, the doctor, or the architect in order to win corresponding professional success.

A distinguished lawyer in San Francisco said to me, after several years of intimate association with the late Arthur L. Adams in a long lawsuit involving an enormous amount of engineering detail, "I used to think that lawyers were the hardest working men in professional circles, but now I take off my hat to the engineers."

Lawyers, doctors, architects, and engineers all have a great amount of work to do to keep up with the new things of their professions, but this is particularly true of engineering, which in many of its important features is changing more rapidly than any other profession. New materials, processes, and devices are continually being added to the general equipment that the engineer must use to get the most economical results, and he must therefore spend a large amount of time in reading and studying, outside of the time employed on

*Part of address delivered at Stanford University under the auspices of the Committee on Vocational Guidance, February 15, 1917

†Consulting engineer, Foxcroft Bdg., San Francisco.

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the special work that he may have in hand, which in itself is generally most exacting. Sound engineering plans are not produced by inspiration, but by hard work; they are evolved by carefully working out every detail and co-ordinating each into a comprehensive and complete plan of development.

Many other qualities are desirable for success in engineering; courage, tact, and diplomacy, and the ability to make and keep friends are most essential. In fact, the success of the consulting engineer in private practice is often as much dependent upon his circle of friends and acquaintances as upon his technical knowledge or executive ability.

One of the most important qualifications for success in engineering is the ability to write and speak English correctly and forcefully. Many a good project has been turned down by interested capitalists because the engineer's report was so poorly written that it failed either to hold their attention during its perusal or to carry conviction at the end; while others of comparatively little merit, have been taken up because they were presented in clear and convincing English.

There are many occasions, too, when the ability to speak in public or before a board of directors is most important for the engineer. This ability is a natural gift with few, but it can be cultivated. In the past engineers have been prone to neglect the cultivation of this ability in the belief that it was of relatively small importance to them as compared with its importance to the lawyer or the clergyman, and that engineering required action rather than fluent speech. This, to my mind, is a mistake, and I believe that one of the most important things that the engineer can do in college, outside of the course of study prescribed, is to acquire the ability of expressing himself clearly in writing or on his feet before an audience.

Clear writing and forceful speaking are the result of clear thinking, they are the expressions of the essence of the man's mentality. One may have a vast amount of accurate detail knowledge of engineering matters, but unless he can produce this knowledge rapidly and in logical sequence, it is frequently of little value to him. I have often thought that our technical colleges might be of great help to young men in this respect by giving them some special training in the art of clear thinking, teaching them how to direct their minds along a given course of thought in such a way as to enable them to obtain accurate and comprehensive results with the least amount of effort.

One of the first things that an experienced engineer does when a large engineering project is presented to him, is to consider rapidly the various steps he will take to produce the final result, what assistants he will employ, what surveys he will make, what data he must collect and how he will obtain them, how he will analyze and arrange them, what plant-machinery or structures will be required, what studies and investigations he will make, how he will present his report, how, if he is authorized to do so, he will proceed with its construction, what methods will he employ, how long each step in the process will take, how the whole will appear and just what its functions or uses will be when completed. He outlines the whole process in his mind, and his ability to do this quickly, clearly, and logically will be of great assistance to him in his future work.

While this ability can only be perfected by experience, I believe engineering students might be materially helped by giving them some definite and systematic training along these lines in addition to instruction in fundamentals and good practice. Even without assistance from those more experienced, the engineering student can train himself in this matter of clear and logical thinking.

This leads me to point out another quality of mind which I think the engineer should cultivate, and that is imagination; not the habit of imagining things that are fantastic or visionary, but the ability of conceiving in his mind quickly and accurately those things which, later on, his skill is to fashion into tangible realities.

There are two moments in connection with any important piece of work which stand out prominently in the experience of every engineer. The first is when his trained imagination has mentally visualized the thing to be done; when he can see in his mind his railroad threading its way across plains, climbing mountain sides, crossing rivers, uniting distant towns and cities, carrying passengers with safety and dispatch, and bearing the commerce of a nation; when he can see his bridge spanning the mighty river, or the mountain torrent harnessed and supplying light and power to homes and industries or, again, conducted to cities of large population to promote health and cleanliness. The second is when he sees such a creation of his imagination stand before him an actual and tangible reality, complete in all its details. Between the two there is much hard work and many trials and discouragements, but in the end there is ample compensation.

The accuracy of the preliminary estimates of mineral production prepared by the U. S. Geological Survey is discussed in the annual report of the Director of the Survey. The Survey's estimate of the gold output of Alaska for 1915, published January 1, 1916, exceeded the final figures by less than 1.2%. The preliminary estimates of the country's production of cement have varied less than 0.5% of the final figures. Similar accuracy is noted in other lines, the preliminary estimates seldom differing more than 2% from the final figures.

Oil from the black shale occurring in several of the eastern States is discussed in Bulletin 641-L of the U. S. Geological Survey, by George H. Ashley. It is probable that many billion barrels could be obtained from these shales, but the cost of production would be too high to make it profitable at the present time. Should the price of oil increase to $4 or $5 per barrel, it might be feasible to develop these shales.

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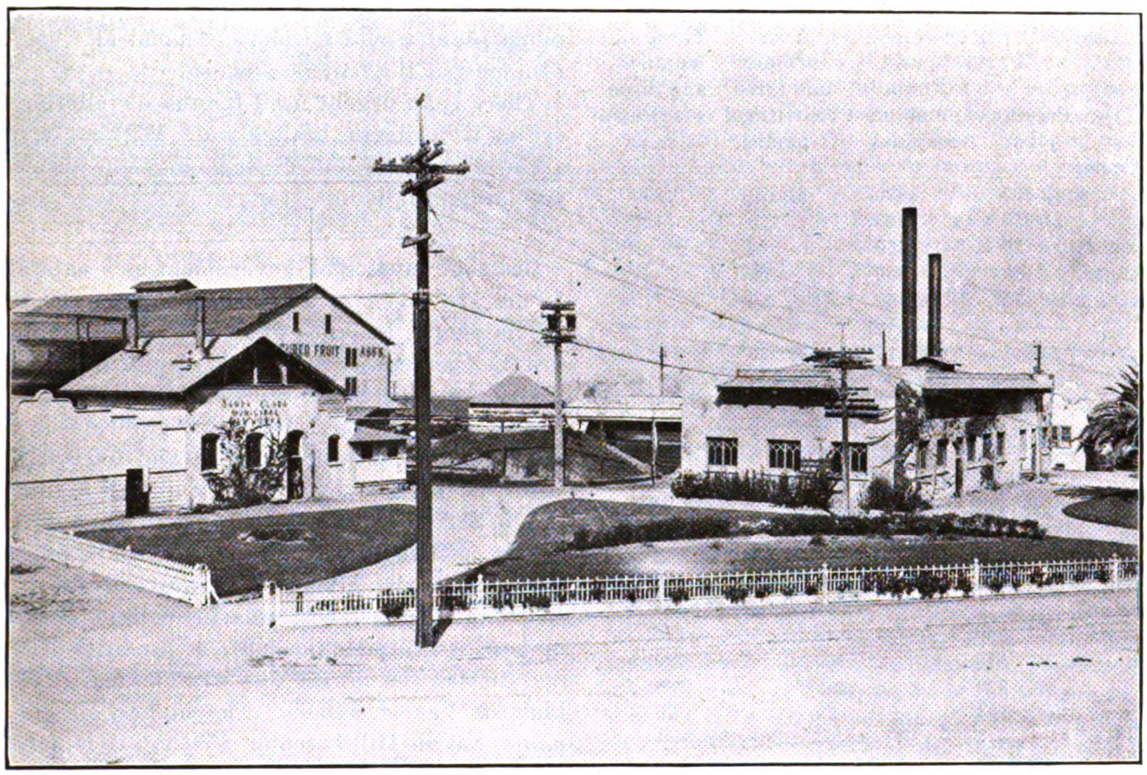
Selection of Pumps for Municipal Plant at Santa Clara, California*

By GEORGE L. SULLIVAN†

Santa Clara is a town of 6000 inhabitants in the centre of the Santa Clara valley. The town owns and operates its own gas and water-plants and also retails electricity, which it buys from the Pacific Gas & Electric Co. A supply of good water is obtained from artesian wells north of the pumping-plant. The water is pumped by centrifugal pumps from these wells into a settling-tank or cistern at the ground-level. From this cistern the water flows by gravity to three plunger-pumps, which deliver it to the mains at from 40 to 50 lb. per square inch.



VIEW OF PLANT.

There are two Worthington duplex pumps and one triple-expansion duplex Dow pumping-engine without flywheel. There is one 125-hp. and two 75-hp. boilers. The pumps are old, worn, and inefficient. The object of this investigation was to determine what type of pumps would be most suitable to replace the old ones.

Six different types of plant were considered and compared with the present plant. These were:

1. Two steam pumping-engines.
2. Two steam-turbines driving three centrifugal pumps.
3. Three low-pressure oil-engines driving three centrifugal pumps.
4. Two low-pressure oil-engines driving two plunger-pumps.
5. Three electric-motors driving three centrifugal pumps.
6. Two electric-motors driving two plunger-pumps.

Any of the first four types would replace the three pumps now in service. The fifth or sixth would replace the Worthington pumps only. The Dow pumping-engine would have to be kept in running order in case the electric service was interrupted during a fire. In case new steam-units are installed, the two 75-hp. boilers will soon have to be replaced. If oil-engines or electric-motors are installed, the present boiler-plant will carry the load for a long time, as the 125-hp. boiler is in good condition.

Tests showed that the Dow pump was delivering 625 gal. per min., and each Worthington pump 360 gal. per min. under ordinary conditions. For fire-duty the pumps are speeded up to give 100 lb. per sq. in pressure. Using these discharge-rates, the records show

*Abstract of report to board of trustees of town of Santa Clara.

†Professor of mechanical and electrical engineering, University of Santa Clara, Santa Clara, California.

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that an average of 663,000 gal. per day is pumped during the year, ranging from 1,040,000 gal. per day, during June down to 381,000 gal. per day during January.

This shows that a plant with a capacity of 1200 gal. per min. against 50 lb. pressure for ordinary duty and 100 lb. pressure for fire-duty would be ample for a long time to come. In addition to the 1200-gal. pumping-unit, a small pump for use during the winter months and at night would be economical. The plant proposed consists of one unit to deliver 1200 gal. per min., against a maximum pressure of 100 lb. per sq. in. and one unit to deliver 500 gal. per min. against a maximum pressure of 50 lb. per square inch.

The costs of machinery and supplies in the following table are based on prices in July 1916 and would have to be increased for later conditions.

First Cost and Cost of Operation Per Year

	Present plant	Two pumping-engines	Two turbines and three centrifugal pumps	Three oil-engines and three centrifugal pumps
Fuel-oil at 2c. per gal.	$3,300	$670	$1,070	$500
Repairs	350	165	100	220
Depreciation	80	550	370	670
Interest	96	660	450	690
Insurance	15	100	66	100
Total	$3,841	$2,145	$2,056	$2,180
Present worth	$1,600	$11,000	$7,500	$11,500

	Two oil-engines and two plunger pumps	Three-electric motors and three centrifugal pumps	Two electric-motors and two plunger-pumps
Fuel-oil at 2c. per gal.	$375	.....	.....
Electricity	....	$2,250	$1,650
Repairs	260	48	120
Depreciation	810	160	400
Interest	900	192	480
Insurance	134	29	70
Total	$2,479	$2,679	$2,720
Present worth	$15,000	$3,200	$8,000

In this investigation it was assumed that the cost of attendance and supplies for all the plants would be the same. This is only approximately correct. With electric-motors the engineers would have less to do than in the case of oil or steam-plants, but, on the other hand, the Dow engine would have to be kept ready to run at any time if electric-motors were installed. No charge could properly be made for banked fires, as steam must be maintained for the gas-plant and for the steam-engine that operates the centrifugal pump in the wells. The oil-engines would use slightly more lubricating oil than the other installations.

The following assumptions were made:

Depreciation of oil-engines, per year	6%
Depreciation of other machinery, per year	5%
Repairs on oil-engines, per year	2%
Repairs on other machinery, per year	1½%
Water-rate of turbines	30 lb.
Water-rate of pumping-engines	25 lb.
Oil consumption of oil-engines, per horsepower-hour	1 lb.
Efficiency of centrifugal pumps	60%
Efficiency of plunger-pumps	80%
Efficiency of pumping-engines	80%
Efficiency of electric-motors and centrifugal pumps combined	55%
Evaporation of boilers, lb. of steam per lb. of fuel-oil	14 lb.
Present worth of pumps now in use	junk value

The table shows plainly that the present plant could be given away with profit, and that an up-to-date plant would save enough to pay for itself in five years interest, depreciation and all other expenses. All the proposed plants are so close together in performance that it would require careful analysis of load factors and latest prices to determine the most economical plant. It is believed that an oil-engine centrifugal pump plant would be most economical when its independence of the boilers is considered.

There is an urgent need for the installation of a recording water-meter in the plant. Without it, the fluctuation of demand and consequently the proper size of pumping-units is uncertain.

Costs of municipal government per capita in California are given in a recent report of the State Tax Commission. In cities of over 100,000 population, the cost in Oakland is $13.11 per capita; in Los Angeles, $14.16; and in San Francisco, $23.66. Costs in San Francisco include also the county government. In cities with populations between 30,000 and 100,000, the lowest cost was in San Jose, $8.70 and the highest in San Diego, $22.41. In cities between 15,000 and 30,000 the lowest cost was in San Bernardino, $4.92 and the highest in Alameda, $12.44. In cities between 10,000 and 15,000, the lowest cost was in Vallejo, $5.79 and the highest in Santa Monica, $24.32. In cities between 5000 and 10,000, the lowest was in Coalinga, $2.57 and the highest, Venice, $15.69. The highest of any municipality was in Hillsborough, $59.26. It is hardly necessary to point out that a low per capita cost may not mean an efficient government.

Steel merchant-ships now under construction in the United States number 403 with a total capacity of 1,495,601 gross tons. In addition there are 118 Government vessels under construction, with a displacement of 395,537 tons. Of the merchant-ships, 45 with a capacity of 214,488 gross tons are being built at Californian yards, and 47 with a capacity of 237,543 at Puget Sound and Columbia River yards.

A National bureau of well-log statistics similar to that now maintained by the oil and gas department of the California State Mining Bureau was proposed by W. G. Matteson, of Bartlesville, Oklahoma, at a recent meeting of the American Institute of Mining Engineers.

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Industrial Progress

AN IMPROVED HEATER AND SPRAYER FOR HIGHWAY WORK

The Kinney Manufacturing Co. has recently perfected a small heater and sprayer for applying oil or asphaltum by the penetration method on small pieces of highway construction, where the expense of heavy truck equipment is not justified. In this class of work it is superior to horse-drawn equipment.

HEATER AT WORK.

The heater is equipped with a gasoline engine, a Kinney rotary pump, and a four-foot spray-bar. It is particularly suited to E-grade asphaltum. The material in the heater is circulated with the power-equipment, and overheating is thereby prevented. However, no steam is required in the process. This heater has been approved by the highway commissions of several States.

Civil Service Examinations

ARCHITECTURAL AND STRUCTURAL STEEL DRAFTSMAN. April 18-19. Salary $1500. Five years' experience in engineering work or drafting or graduation from a technical school and two years' experience. Age 22 or over. Usual places of examination. Application form 1312.

ASSISTANT INSPECTOR OF ENGINEERING MATERIAL. April 18. Salary $4 to $4.48 per day. Three years' experience in mechanical engineering or graduation from a technical school and one and one-half years' experience required. Age 22 or over. Usual places of examination. Application form 1312.

CALIFORNIA STATE CIVIL SERVICE COMMISSION, April 13-14. Civil Engineer. Salary $100 to $150 per month. Candidates will be examined in mathematics, surveying, and civil engineering, and will also be rated on experience. Examination will be neld in Sacramento, San Francisco, and Los Angeles. Applicants should obtain form No. 2 from the commission at Sacramento, and file same before April 7.

Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Wilkie Woodard, secretary, 435 Consolidated Realty building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

A meeting of the PETROLEUM CLUB OF THE UNIVERSITY OF CALIFORNIA was held at Berkeley on March 29. J. O. Lewis, of the U. S. Bureau of Mines, addressed the club on 'Increasing Recovery of Oil by Means of Compressed Air.'

The course of 17 military lectures to engineers which is given under the joint auspices of the U. S. Army and the military affairs committee of the San Francisco members of the National engineering societies was opened at Native Sons Hall, San Francisco, on March 13 with a lecture on 'The United States Army, its Officers and Enlisted Reserve Corps,' by Major-General Bell. The attendance at this lecture was about 800. The lecture on March 20 was delivered by Captain Park, and on March 27, by Captain Marshall. The attendance at each of these lectures was over 500.

The ASTORIA SOCIETY OF ENGINEERS was recently organized; it will be affiliated with the Oregon Society of Engineers. The following officers were elected: president, A. C. Ross; vice-president, R. R. Bartlett; secretary and treasurer, L. D. Williams; directors, W. A. Hanscom, G. T. McLean, and George Stevens.

The February meetings of the Los Angeles Section of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, southern California Chapter of the American Institute of Architects, and the Engineers and Architects Association of Southern California were held with the Broadway Improvement Association on February 6, 1917. W. D'Arcy Ryan, illuminating engineer for the General Electric Co., showed his private collection of color-slides of the illumination of the Panama-Pacific Exposition and other slides pertaining to modern illumination. He also showed water-color drawings of the proposed new lighting standards for the Broadway lighting system, which is to be called the 'Path of Roses.'

Coming Conventions

PORTLAND CEMENT ASSOCIATION. Spring meeting, San Francisco, April 16-18. H. E. Hilts, Pacific Coast representative, Rialto Bdg., San Francisco.

AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting, Atlantic City, New Jersey, June 26-30.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS, Ottawa, Canada, April 10-14.

Personal

H. S. FORNERI, formerly city engineer of Eugene, Oregon, has resigned, and will open offices at San Diego.

CHARLES D. BLANEY, who has been a member of the California State Highway Commission since its formation, has

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resigned because of ill health. He has been succeeded by HENRY J. WIDENMANN of Vallejo.

O. H. BUCKMAN has been appointed city engineer of Napa, California, succeeding the late J. E. GARDNER.

ROBERT P. FLAGEL is investigating silt-deposition on the San Juan river, in Utah, for the U. S. Geological Survey.

JOHN BURT has been appointed superintendent for the Marin Municipal water district succeeding S. M. AUGUSTINE.

O. J. DESPAIN, county engineer of Adams county, Washington, has also been appointed city engineer of Ritzville.

F. D. STANLEY and J. W. BAILEY have opened offices at Baker, Oregon. They will engage in general engineering practice.

The city council of Portland has requested J. L. STANNARD to report upon the proposed plan for a municipal hydro-electric plant.

R. R. FISCHER, who has been connected with the city engineer's office at Los Angeles, has been appointed deputy city engineer of Fresno.

J. G. SCRUGHAM, dean of the engineering college of Nevada State University, has resigned to accept the position of State engineer for Nevada.

CARL H. REEVES, JOHN L. HALL, and AMOS SLATER have opened offices at 445 Henry Bdg., Seattle. They will engage in general engineering practice.

MAJOR ELLIOTT J. DENT, who has been stationed at Little Rock, Arkansas, has been ordered to Portland, Oregon, to take charge of the U. S. Engineer Office.

O. A. RICKERS, formerly chief draftsman in the office of the U. S. surveyor-general at Salt Lake City, has been appointed city engineer of Huron, South Dakota.

D. ARRELL, formerly connected with the Kern County Oil Protective Association, has been appointed assistant to the deputy oil and gas supervisor with headquarters at Taft, California.

PAUL P. WHITHAM has been appointed consulting engineer by the U. S. Bureau of Foreign and Domestic Commerce, and will make a study of port and transportation facilities of Russia and the Far East.

W. J. DAVIS, JR., of San Francisco, addressed a joint meeting of the Portland sections of the American Institute of Electrical Engineers and the National Electric Light Association on 'Steam-Turbines and Reduction-Gears for Ship Propulsion.'

WILBUR J. WATSON, WILLIAM R. DAVIS, and HARLAN D. MILLER, who designed one of the proposed bridges across San Francisco bay under the name of The Associated Engineers, have formed the WATSON, DAVIS, MILLER CO., and will conduct a general engineering practice with offices at Albany, New York, Cleveland, Ohio, and 1216 Merchants National Bank Bdg., San Francisco.

JOSHUA GREENWOOD, WARREN STOUTHOUR, and HENRY H. BLOOD have been appointed members of the newly authorized public utilities commission of Utah. Mr. Greenwood is a lawyer. Mr. Stouthour is a civil engineer, whose principal experience has been in railroad work. Mr. Blood is a businessman who is connected with a number of enterprises.

The following officers were elected at a recent meeting of the California State Association of County Surveyors: president, J. A. SOURWINE, San Bernardino county; vice-president, M. C. POLK, Butte county; secretary and treasurer, DRURY BUTLER, Sacramento county; executive committee, B. O. LOVELACE, Tulare county; J. L. MCBRIDE, Orange county; H. F. COZZENS, Monterey county; and J. W. KAERTH, Colusa county.

The following officers have been appointed for the Federal Farm Loan Bank at Berkeley, California: president, BURREL G. WHITE, San Francisco; vice-president, R. L. DOUGLASS, Fallon, Nevada; secretary, S. A. REED, Los Angeles; treasurer, GEORGE W. THOMAS, Logan, Utah. These officers, together with ELWOOD MEAD of Berkeley, will constitute the directorate. LYSANDER CASIDY, Phoenix, Arizona, has been appointed registrar and attorney.

Obituary

J. E. GARDNER, city engineer of Napa, California, died at Oakland, March 13.

THEODORE N. BARNSDALL, pioneer oil and gas operator in almost every field in the United States, died February 27 at his home in Pittsburgh, Pennsylvania.

ARTHUR BROWN, for many years consulting engineer for the Central and Southern Pacific Railroads, and who had charge of bridge-work during the original construction of the Central Pacific across the Sierra, died at his home in Oakland, on March 9. He was 86 years old.

JOHN KASSON HOWE died March 4 at Albany, New York. Mr. Howe organized the Osgood Dredge Co. in 1883 and was secretary and treasurer of that company until its consolidation with the Osgood Co. of Marion, Ohio, when he became a director of the latter company and its Eastern sales representative.

GEORGE HENRY FROST died March 15 at his home at Plainfield, New Jersey. Mr. Frost founded the *Engineer and Surveyor*, afterward the *Engineering News*, in 1874. It was originally published in Chicago, but was moved to New York in 1878. He was the publisher and chief owner until the publication was bought by the Hill Publishing Co. in 1911.

Commercial Paragraphs

FAIRBANKS, MORSE & CO. and the CALIFORNIA NATIONAL SUPPLY CO. have entered into an agreement by which the latter company will handle the Fairbanks pumps for oilfield service throughout California.

C. F. BRAUN & CO., 503 Market street, San Francisco, are constructing a factory on Folsom street, which will be completed about April 15, for the manufacture of the centrifugal pumps and other machinery that they handle.

G. F. Montfort has recently been placed in charge of the Pacific Coast district for the GOOD ROADS MACHINERY CO. Mr. Montfort has been for the past 25 years manager of the Pittsburg division for the same company, and has also spent much time in Italy and France, studying road-building methods.

The PACIFIC CONCRETE PIPE ASSOCIATION, composed of concrete-pipe manufacturers in Oregon, Washington, and parts of California and Utah, was recently organized at a meeting held at Portland. The following officers were elected: president, C. H. Bullen, Portland; vice-president, George H. Schofield, Tacoma; secretary, H. W. Shaw, Everett. The new organization will work for standardization of concrete sewer, culvert, and drain pipe.

The McGraw Publishing Co., Inc., and the Hill Publishing Co., New York, have been consolidated as the MCGRAW-HILL PUBLISHING CO., INC. The new company acquires all the properties and interests of the two constituents, including the following technical journals: *Electrical World*, *Electrical Railway Journal*, *Electrical Merchandising*, *Engineering Record*, *Metallurgical and Chemical Engineering*, *The Contractor*, *American Machinist*, *Power*, *Engineering News*, *Engineering and Mining Journal*, and *Coal Age*. Two of these papers, *Engineering News* and *Engineering Record* will be consolidated under the name, *Engineering News-Record*, with Charles Whiting Baker, now editor of *Engineering News*, as editor-in-chief. The first issue of the consolidated paper will appear April 5. James H. McGraw will be president of the new company, Arthur J. Baldwin, formerly president of the Hill Publishing Co., vice-president and treasurer, and E. J. Mehren, formerly editor of the *Engineering Record*, vice-president and general manager.

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Western Engineering

WEEKLY NEWS BULLETIN

WESTERN ENGINEERING *with* WEEKLY NEWS BULLETIN $4.50 per Year

SAN FRANCISCO, APRIL 2, 1917

SINGLE COPIES WEEKLY NEWS BULLETIN 15 Cents

Contracts Pending

Bids will be Received		See Issue of News Bulletin
Apr. 2.	Arcadia, Cal, Light	Mar. 26
Apr. 2.	Beverly Hills, Cal., Light	Mar. 26
Apr. 2.	Chehalis, Wash., Bridge	Mar. 19
Apr. 2.	Everett, Wash., Road Work	Mar. 19
Apr. 2.	Fresno, Cal., Building	Mar. 12
Apr. 2.	Fresno, Cal., Building	Apr. 2
Apr. 2.	Fresno, Cal., Sewer	Mar. 19
Apr. 2.	Healdsburg, Cal., Sewers	Apr. 2
Apr. 2.	Hollister, Cal., Bridges	Mar. 19
Apr. 2.	Los Angeles, Cal., Street Work	Apr. 2
Apr. 2.	Los Angeles, Cal., Supplies	Mar. 19
Apr. 2.	McMinnville, Ore., Miscellaneous	Apr. 2
Apr. 2.	Merced, Cal., Street Work	Mar. 12
Apr. 2.	Newport, Wash., Road Work	Mar. 26
Apr. 2.	Sacramento, Cal., Road Work	Mar. 26
Apr. 2.	San Jose, Cal., Culvert	Apr. 2
Apr. 2.	San Diego, Cal., Irrigation	Mar. 19
Apr. 2.	San Diego, Cal., Machinery	Mar. 19
Apr. 2.	San Diego, Cal., Street Work	Mar. 26
Apr. 2.	San Diego, Cal., Street Work	Apr. 2
Apr. 2.	San Francisco, Cal., Supplies	Mar. 12
Apr. 2.	San Jose, Cal., Supplies	Mar. 19
Apr. 2.	Shelton, Wash., Road Work	Mar. 26
Apr. 2.	Whittier, Cal., Street Work	Apr. 2
Apr. 2.	Yreka, Cal., Road Work	Mar. 19
Apr. 2.	Yreka, Cal., Supplies	Mar. 19
Apr. 3.	Covina, Cal., Water Supply	Mar. 19
Apr. 3.	Kingman, Ariz., Buildings	Mar. 26
Apr. 3.	Livingston, Mont., Bridge	Apr. 2
Apr. 3.	Santa Rosa, Cal., Supplies	Apr. 2
Apr. 3.	Stockton, Cal., Building	Mar. 26
Apr. 3.	Stockton, Cal., Road Work	Mar. 19
Apr. 3.	Wenatchee, Wash., Machinery and Supplies.	Apr. 2
Apr. 3.	Wenatchee, Wash., Road Work	Apr. 2
Apr. 4.	Denver, Colo., Machinery	Mar. 19
Apr. 4.	Gold Beach, Ore., Miscellaneous	Mar. 5
Apr. 4.	Ritzville, Wash., Bridge	Apr. 2
Apr. 4.	San Francisco, Cal., Building	Mar. 26
Apr. 4.	San Francisco, Cal., Street Work	Apr. 2
Apr. 4.	Santa Barbara, Cal., Supplies	Apr. 2
Apr. 4.	Seattle, Wash., Building	Apr. 2
Apr. 4.	South Bend, Wash., Bridge	Mar. 26
Apr. 4.	South Bend, Wash., Road Work	Mar. 26
Apr. 5.	Calexico, Cal., Irrigation	Apr. 2
Apr. 5.	St. Ignatius, Mont., Irrigation	Mar. 19
Apr. 5.	Santa Barbara, Cal., Sewer	Apr. 2
Apr. 5.	Santa Barbara, Cal., Street Work	Mar. 26
Apr. 5.	Santa Barbara, Cal., Street Work	Apr. 2
Apr. 6.	Eureka, Cal., Street Work	Apr. 2
Apr. 6.	Jerome, Ariz., Street Work	Mar. 19
Apr. 6.	Portland, Ore., Building	Apr. 2
Apr. 6.	Seattle, Wash., Supplies	Apr. 2
Apr. 6.	Stockton, Cal., Street Work	Apr. 2
Apr. 7.	San Francisco, Cal., Water Supply	Mar. 12
Apr. 9.	Calexico, Cal., Building	Apr. 2
Apr. 9.	Hailey, Ida., Bridge	Apr. 2
Apr. 9.	Los Angeles, Cal., Street Work	Mar. 26
Apr. 9.	Oakland, Cal., Building	Apr. 2
Apr. 9.	Oakland, Cal., Machinery	Apr. 2
Apr. 9.	Seattle, Wash., Road Work	Mar. 26
Apr. 10.	Berkeley, Cal., Road Work	Apr. 2
Apr. 10.	Eureka, Cal., Road Work	Mar. 26
Apr. 10.	Fairfield, Cal., Street Work	Apr. 2
Apr. 10.	Modesto, Cal., Building	Mar. 19
Apr. 10.	Modesto, Cal., Road Work	Mar. 26
Apr. 10.	Richvale, Cal., Culverts	Mar. 26
Apr. 10.	Richvale, Cal., Supplies	Mar. 26
Apr. 10.	San Diego, Cal., Road Work	Apr. 2
Apr. 10.	San Jose, Cal., Building	Apr. 2
Apr. 10.	Seattle, Wash., Supplies	Apr. 2
Apr. 11.	Honolulu, Hawaii, Harbor Work	Mar. 26
Apr. 11.	Riverside, Cal., Bridge	Apr. 2
Apr. 12.	Bakersfield, Cal., Buildings	Mar. 26
Apr. 12.	Tacoma, Wash., Road Work	Mar. 26
Apr. 13.	Astoria, Ore., Water Supply	Mar. 26
Apr. 13.	Seattle, Wash., Supplies	Apr. 2
Apr. 14.	Denver, Colo., Machinery and Supplies	Mar. 26
Apr. 16.	Coalinga, Cal., Buildings	Apr. 2
Apr. 16.	Colfax, Wash., Road Work	Apr. 2
Apr. 16.	Everett, Wash., Road Work	Apr. 2
Apr. 16.	Fort Keogh, Mont., Supplies	Mar. 26
Apr. 16.	Los Angeles, Cal., Sewer	Apr. 2
Apr. 16.	San Francisco, Cal., Miscellaneous	Mar. 12
Apr. 16.	San Francisco, Cal., Supplies	Mar. 26
Apr. 18.	Denver, Colo., Machinery	Mar. 26
Apr. 18.	Powell, Ida., Irrigation	Apr. 2
Apr. 18.	St. John, Ariz., Buildings	Apr. 2
Apr. 19.	Bozeman, Mont., Street Work	Apr. 2
Apr. 20.	Sacramento, Cal., Building	Apr. 2
Apr. 20.	Washington, D. C., Building	Apr. 2
Apr. 22.	Tacoma, Wash., Machinery	Apr. 2
Apr. 23.	Newport Beach, Cal., Harbor Work	Mar. 26
Apr. 23.	Reno, Nev., Machinery and Supplies	Apr. 2
Apr. 23.	Seattle, Wash., Machinery and Supplies	Apr. 2
Apr. 25.	Malta, Mont., Irrigation	Apr. 2
May 1.	Astoria, Ore., River Work	Mar. 19
June 1.	Calcutta, India, Sewer	Jan. 2

Building Permits

In SAN FRANCISCO; $2500 and over in valuation.

MARCH 23

TENEMENT ALTERATIONS—Cost $20,000. T. J. Wrampelmeier, owner. S Greenwich 73 W Van Ness Ave.

ONE STORY BRICK SHOP—Cost $10,000. Triangle Co., owner. W 8th 135 N Mission.

TWO STORY BRICK STORES AND OFFICES—Cost $30,000. Commercial Center Realty Co., owner. NE Green and Stockton.

(Continued on page 164)

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Construction News

STREET AND ROAD WORK

BAKERSFIELD, CAL.—Contract for improvement of 20th street has been awarded to Thompson Bros., 1514 H street, Fresno, for $9535.15. California Road & Street Improvement Co. bid $9895.10.

Following prices were named by Thompson Bros., Fresno, who were awarded contract for improvement of 20th street: grading and asphaltic concrete pavement, $0.145 per sq. ft.; concrete gutters, $0.17 per sq. ft.; concrete curbs, $0.35 per ft.; concrete sidewalks, $0.12 per sq. ft.; 18-in. culverts, $2 per ft.; 12-in. culverts, $2 per foot.

BERKELEY, CAL.—Bids will be received until 10 a.m., April 10, by C. H. Sweetser, district engineer, Office of Public Roads, Federal Bdg., for construction of Laguna highway in Cleveland National Forest, 9.4 miles.

BLYTHE, CAL.—Contract for construction of concrete curbs and sidewalks on several streets has been awarded to James Johnson, 1728 South Oxford boulevard, Los Angeles, for $35,000.

BOZEMAN, MONT.—Bids will be received until 5 p.m., April 19, by C. A. Spieth, city clerk, for construction of pavement and storm-sewers in district No. 145, including 4200 sq. yd. bitulithic pavement and 924 ft. of 10 to 18-in. sewer. Plans from city clerk upon deposit of $5.

CALISTOGA, CAL.—City trustees have decided to pave Lincoln avenue and Washington street with concrete with oil and screenings wearing surface.

CHINO, CAL.—Contract for street improvements has been awarded to George H. Oswald, O. T. Johnson Bdg., Los Angeles, for $28,950.

CLE ELUM, WASH.—Contract for construction of 3½ miles of permanent highway has been awarded to Hutter Construction Co. for $13,974.

COLFAX, WASH.—Bids will be received until April 16 by A. R. Metz, county auditor, for grading and graveling permanent highway No. 12, about 12 miles.

EDMONDS, WASH.—Contract for paving Main street has been awarded to A. L. Clark, L. C. Smith Bdg., Seattle, for $1744.33.

EUREKA, CAL.—Bids will be received until 5 p.m., April 6, by J. P. Wunderlich, city clerk, for grading Buhne street and Garland street.

EVERETT, WASH.—Bids will be received until April 16 by M. Weatherbee, county auditor, for construction of permanent highways No. 24 and 31.

Contract for construction of concrete pavement on permanent highways No. 4, 5, and 34 have been awarded to Washington Paving Co., L. C. Smith Bdg., Seattle, for $13,838; $32,078; and $31,132 respectively.

FAIRFIELD, CAL.—Bids will be received until 8:30 p.m., April 10, by F. L. Morrill, town clerk, for re-surfacing Texas street.

LONG BEACH, CAL.—Contract for improvement of several streets has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $50,976.08.

LOS ANGELES, CAL.—Bids will be received until 10 a.m., April 2, by Board of Public Works for construction of concrete curbs, sidewalks, and gutters and vitrified-pipe storm-sewers on Ambrose avenue.

Contract for improvement of Baxter street has been awarded to O. L. Stevens, 1933 Arapahoe street, Los Angeles, for $2250.96.

MARTINEZ, CAL.—Bids are being received by J. H. Wells, county clerk, for grading highway between Antioch and Oakley, including 6000 cu. yd. excavation.

NORTH YAKIMA, WASH.—Contract for construction of concrete sidewalks in district No. 270 has been awarded to Washington Paving Co., L. C. Smith Bdg., Seattle, for $23,092. Contract for construction of sidewalks in district No. 269 has been awarded to J. L. Smith, 1475 20th avenue, Seattle, for $6009.

OAKLAND, CAL.—Board of Supervisors will spend $100,000 in paving East 14th street between 50th avenue and Stanley road.

PORTLAND, ORE.—Contract for paving St. Helens highway, 11 miles, has been awarded to Warren Construction Co., Journal Bdg., Portland, for $180,922.08, for bitulithic pavement on crushed-rock base.

RENO, NEV.—City will spend $40,000 for street paving during coming season.

RODEO, CAL.—Main street of town will be improved. County will construct oil-macadam pavement by day labor, and property-owners will construct concrete curbs and sidewalks by private contract.

SACRAMENTO, CAL.—State highway commissioner Charles F. Stern has announced that the Commission will let contracts for $3,000,000 worth of highway work about May 1.

No bids were received by supervisors for construction of highway in Fairoaks, and work will be done by day-labor under supervision of county surveyor Drury Butler.

SAN DIEGO, CAL.—Bids will be received until 10 a.m., April 2, by A. H. Wright, city clerk, for construction of concrete pavement on Fourth street.

Bids will be received until 11 a.m., April 10, at U. S. Engineer Office, for construction of roads at Fort Rosecrans.

SAN FERNANDO, CAL.—Contract for construction of disintegrated-granite pavement and concrete curbs, sidewalks, and gutters on Macneil street has been awarded to Heinauer & Kyle, Watts, for $2500.

SAN FRANCISCO, CAL.—Bids will be received until 2 p.m., April 4, by Board of Public Works for the following street work: concrete curbs and asphalt pavement on Broad street and on Judah street; granite curbs, concrete sidewalks, and asphalt pavement on 14th avenue, and on Hampshire street; concrete curbs and sidewalks and asphalt pavement on Judah street and Irving street.

Board of Public Works has issued call for bids for construction of first section of Marina boulevard. Estimated cost is $30,000.

Bids will be received until 2 p.m., April 4, by Board of Public Works for grading and construction of concrete curbs and sidewalks and asphalt pavement on Girard street.

SAN RAFAEL, CAL.—Contract for construction of highway along pipe-line to Phoenix lake has been awarded by Marin water district to C. B. Cowden, 2078 Green street, San Francisco, for $10,730.69. Other bidders were: John Ferreio, $11,956; Daniel O'Day Co., $12,252.55; J. M. De Luca, $12,257.85; Al Carlson, $13,279.19; Colma Contracting Co., $13,474.23; R. B. Markle, Jr., $13,522.11; A. J. Fairbanks, $14,791.36; L. L. Page, $15,071.35; J. P. Holland, $16,257.60.

SANTA BARBARA, CAL.—Bids will be received until noon, April 5, by A. C. Hall, city clerk, for improvement of several streets.

SEATTLE, WASH.—All bids for construction of Julia Blinn highway have been rejected because too high.

STOCKTON, CAL.—All bids for street improvement in McCloud's addition have been rejected because too high and new bids will be received until April 6, by G. W. Pulich, city clerk.

TACOMA, WASH.—Contract for construction of Hill highway has been awarded to Independent Asphalt Paving Co., Northern Bank Bdg., Seattle, at $34,450 for bitulithic pavement.

WENATCHEE, WASH.—Bids will be received until 2 p.m., April 3, by T. L. Ross, county clerk, for construction of highway.

WHITTIER, CAL.—Bids will be received until 7:30 p.m., April 2, by C. O. Trueblood, city clerk, for improvement of several streets.

SEWERS AND DRAINAGE

HEALDSBURG, CAL.—Bids will be received until 7:30 p.m., April 2, by D. A. Bane, city clerk, for construction of sewers.

LOS ANGELES, CAL.—Bids will be received until 2 p.m., April 16, by Board of Supervisors for construction of sewage-disposal plant on county farm near Downey. Estimated cost is $11,000.

Contract for construction of sewer on Topaz street has been awarded to Leo Miletich, 1018 East 40th street, Los Angeles, for $16,900.

MERCED, CAL.—State Supreme Court has rendered decision that will permit work proceeding in Livingston and Atwater drainage districts. Contract for this work was awarded last fall to Shattuck-Edinger Co. for $97,000, but construction has been delayed by legal difficulties.

NEZPERCE, IDA.—Following bids were received for construction of sewer system: Security Bridge Co., Lewiston, $28,499; Raven Construction Co., San Francisco, $28,690; Elliott Contracting Co., Portland, $28,830.

Contract for construction of sewer system has been awarded to Security Bridge Co., Lewiston, for $28,499.

SANTA BARBARA, CAL.—Bids will be received until noon,

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April 5, by A. C. Hall, city clerk, for construction of 8-in. sewer on Micheltorena street.

BRIDGES AND CULVERTS

BETTERAVIA, CAL.—Bids are being received by Union Sugar Co. for construction of 1080 ft. of timber trestle, 15 ft. high.

HAILEY, IDA.—Bids will be received until 1:30 p.m., April 9, by George McLeod, county recorder, for construction of steel highway-bridge 108 ft. long, over Big Wood river.

LIVINGSTON, MONT.—Bids will be received until April 3 by C. A. Burg, county clerk, for construction of concrete piers for steel bridge across Yellowstone river.

OROVILLE, CAL.—Great Western Power Co., 14 Sansome street, San Francisco, will construct concrete and steel highway bridge across Feather river, in connection with its proposed power project.

RITZVILLE, WASH.—Bids will be received until April 4 by L. Schragg, county clerk, for construction of reinforced concrete bridge across Cow creek.

RIVERSIDE, CAL.—Bids will be received until April 11 by A. B. Pilch, county clerk, for construction of bridge across Snow creek.

SAN FRANCISCO, CAL.—Northwestern Pacific Railroad Co. will build steel bridge across Russian river at Duncans Mill.

SAN JOSE, CAL.—Bids will be received until noon, April 2, by T. H. Reed, city manager, for construction of concrete or corrugated-pipe culvert at Pierce avenue and Orchard street.

IRRIGATION AND WATER SUPPLY

CALEXICO, CAL.—Bids will be received until April 5 by J. C. Allison, Anderson Bdg., Calexico, for construction of 6½ miles of irrigating-canal for Black Butte Development Co. Work is in Imperial valley in Mexico, about 25 miles southeast of Calexico. Canal is to be from 14 to 16 ft. wide on the bottom, with 4 to 5-ft. banks. Work involves 100,000 cu. yd. earth excavation.

LOS ANGELES, CAL.—W. H. Holabird, Title Insurance Bdg., Los Angeles, is interested in plan to divert water from Whitewater river for irrigation in Coachella valley and for domestic use in Imperial valley. Plans include storage dam, 105 miles of open concrete-lined canal, and hydro-electric plants developing 80,000 hp. Total estimated cost is $10,000,000.

MALTA, MONT.—Bids will be received until 2 p.m., April 25, at office of U. S. Reclamation Service, for about 7500 cu. yd. excavation on Milk River project. Work is ten miles from Saco, on the Great Northern Railway.

MARTINEZ, CAL.—Olmsted & Gillelen, Hollingsworth Bdg., Los Angeles, will prepare plans for water and sewer system.

POWELL, IDA.—Bids will be received until 2 p.m., April 18, at office of U. S. Reclamation Service for construction of canals on Shoshone project. Work includes 30,000 cu. yd. excavation, and is near Mantua on the Chicago, Burlington & Quincy railroad.

SAN DIEGO, CAL.—San Dieguito Mutual Water Co. has been formed to irrigate 20,000 acres in this vicinity. Plans include two large concrete dams. Total cost of project is $3,000,000. E. O. Faulkner, Los Angeles, W. G. Henshaw, San Francisco, and Ed Fletcher, San Diego, are interested.

Sharp & Fellows Construction Co., Central Bdg., Los Angeles, were low bidders at $92,147 for construction of reinforced concrete dam of Eastwood multiple-arch type at La Mesa for Cuyamaca Water Co. Other bidders were: John Engebresten, $116,700; Bent Bros., $118,000; Henry Fenton, $132,000; Twohy Bros. Co., $157,705.

SAN FRANCISCO, CAL.—State Water Commission has received the following applications for permission to divert water:

Blevins-Mallon Ditch Co., Colusa, 160 second-feet from Sacramento river for irrigation. Plans include pumping plant comprising one 36-in. and two 18-in. motor-driven centrifugal pumps, concrete basin, and main canal 12½ miles long. Estimated cost is $80,000.

J. R. Chinn, Oakville, 2½ second-feet from Napa creek. Plans include motor-driven pumps and 10-in. cement pipe-line. Estimated cost is $2500.

City of Los Angeles has filed several applications to divert water from streams in Kern and Inyo counties for power-purposes.

Cardiff irrigation district, Cardiff, one second-foot from Escondido creek for irrigation and domestic use. Plans include 22,418 ft. of 12-in. pipe and 3619 ft. of 8-in. pipe. Estimated cost is $84,200.

Southern California Edison Co. 600 second-feet of water from Kern river for hydro-electric development. Estimated cost of work is $4,000,000.

LIGHT, HEAT, AND POWER

SAN LEANDRO, CAL.—Contract for construction of electrolier system on East 14th street and Washington avenue has been awarded to D. S. Tamplin, Los Angeles, at $52.75 for each standard or $1908 in all. Other bidders were: Peters, Bronse & Co., San Pedro, $60; and Central Electric Co., San Francisco, $90.

WASHINGTON, D. C.—Following bids were received for heating and power plant at naval torpedo station at Puget Sound, Wash.: Chas. C. Moore & Co., San Francisco, $28,471; J. W. Danforth & Co., Buffalo, $28,747; A. D. Granger, & Co., New York, $49,035; Carrol Electric Co., Washington, D. C., $30,400; Booker, Kiehl & Whipple, Seattle, Wash., bid $24,415 with bidders' modifications.

RIVER AND HARBOR WORK

NORTH BEACH, CAL.—Call for bids for construction of rubble-mound jetty has been cancelled and work has been postponed.

RAILROAD WORK

CARSON CITY, NEV.—State legislature has granted franchise to Walter E. Trent, Reno, for construction of railroad from either Ely or Eureka to Tonopah, about 175 miles.

FLAGSTAFF, ARIZ.—Contract for construction of 10 miles of logging-railroad for Flagstaff Lumber Co. has been awarded to Sharp & Fellows Construction Co., Central Bdg., Los Angeles.

PORTERVILLE, CAL.—Contract for construction of six miles of line for Visalia Electric Railroad has been awarded to Oscar Ford, Riverside.

RENO, NEV.—Western Pacific Railroad will rebuild nearly all of line of Nevada, California & Oregon Railroad between Reno and Hackstaff. Part of the abandoned road-bed will be used as a county highway.

SALT LAKE CITY, UTAH.—Oregon Short Line will spend $4,100,000 and Salt Lake Route $4,500,000 on improvements during coming season.

UPLAND, CAL.—Atchison, Topeka & Santa Fe Railroad will build four-mile branch line.

BUILDING CONSTRUCTION

ALTURAS, CAL.—Nevada, California & Oregon Railroad will construct $40,000 concrete building.

CALEXICO, CAL.—Bids will be received until 7:30 p.m., April 9, by J. B. Hoffman, school clerk, for construction of manual-training building.

CLOVIS, CAL.—Elections will be held on April 10 to vote on bond issue of $60,000 for construction of high-school building, and on April 14 to vote on issue of $25,000 for construction of grammar-school building.

COALINGA, CAL.—Bids will be received until 8 p.m., April 16, by C. T. Walker, city clerk, for construction of steel water-tanks.

COLUSA, CAL.—Contract for construction of school building has been awarded to J. S. Hannah, William Bdg., San Francisco, for $76,150. Other bidders were: Mascow & Morrison, $79,480; D. R. Wagner, $79,970; Thurston & Co., $80,385; F. L. Hanson, $80,880; A. Christensen & Son, Oakland, $80,942; H. A. Klyce, $82,797; R. W. Littlefield, Oakland, $83,560; Robert Trost, $84,290; H. S. Williams, $86,450; W. W. Campbell, Sacramento, $87,300; Anderson & Ringrose, $91,300; Stockholm & Allen, Colusa, $91,630; Garahan & Mulford, $91,816. All bidders are from San Francisco unless otherwise noted.

Contract for plumbing has been awarded to W. P. Boyce & Son, Woodland, for $5997.

Bids for heating were taken under advisement. J. C. Hurley Co., 509 Sixth street, San Francisco, was low bidder at $12,357.

FRESNO, CAL.—Bids are being received by W. H. Ryan, city clerk, for construction of two-story brick building for engine-house No. 2. Estimated cost is $15,000.

Bids will be received until 2 p.m., April 2, by Al Sunderland, secretary California Peach Growers, Inc., Fresno, for construction of packing-house at Reedley.

Contract for construction of packing-house for Universal Packing Co. has been awarded to Trewhitt-Shields Co., Rowell Bdg., Fresno, for $200,000.

MERCED, CAL.—Contract for construction of reinforced concrete building for Catholic church has been awarded to James L. McLaughlin, 244 Kearny street, San Francisco, for $19,500.

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OAKLAND, CAL.—Bids will be received until 5 p.m., April 9, by Dan W. Pratt, secretary board of education, for grading and construction of foundation for unit No. 3 of Lakeview annex school.

PALO ALTO, CAL.—Contract for construction of frame apartment-house for Sarah G. Howard has been awarded to Val France, 180 Jessie street, San Francisco, for $22,514.

SACRAMENTO, CAL.—Bids will be received until 10 a.m., April 20, by C. C. Hughes, secretary board of education, for construction of school building. Plans from secretary or from Shea & Lofquist, architects, 742 Market street, San Francisco, upon deposit of $25.

ST. JOHN, ARIZ.—Bids will be received until noon, April 18, by L. S. Udall, county clerk, for construction of courthouse and jail.

SAN FRANCISCO, CAL.—Contract for construction of building and equipment for water supply for Relief Home has been awarded to Simonds Machinery Co., 117 New Montgomery street, San Francisco, for $6557.

SAN JOSE, CAL.—Bids will be received until 3:30 p.m., April 10, at office of F. D. Wolfe, Auzerais Bdg., San Jose, for construction of five-room frame building for Burbank school district.

SANTA BARBARA, CAL.—Contract for construction of building for First Presbyterian church has been awarded to W. E. Kier Construction Co., American National Bank Bdg., San Diego, for $60,000.

SEATTLE, WASH.—Port of Seattle Commission will receive bids until April 4 for construction of grain-elevator. Bids for this work were received a short time ago, but were rejected because too high, and the plans have been revised.

SELAH, WASH.—Contract for construction of cold-storage plant for Selah Fruit & Cold Storage Co. has been awarded to Scenic Construction Co., Downs Bdg., Seattle, for $50,000.

WASHINGTON, D. C.—Bids will be received until April 20 at office of supervising architect, Treasury Department, for construction of post-office at Las Cruces, New Mexico.

MACHINERY AND SUPPLIES

EUREKA, CAL.—Bids are being received by J. P. Wunderlich, city clerk, for furnishing fuel-oil.

Contract for furnishing automobile fire-engine to city has been awarded to J. J. Schneer for $9000.

LAS VEGAS, NEV.—Contract for furnishing motor-driven combination chemical-engine and hose-wagon to city has been awarded to American La France Company.

MARTINEZ, CAL.—Call for bids for furnishing 15,000 tons of sand and crushed rock for county highway work will be issued soon.

OAKLAND, CAL.—Bids will be received until 5 p.m., April 9, by Dan W. Pratt, secretary board of education, for furnishing an automobile.

PETALUMA, CAL.—Contract for furnishing cement for street work has been awarded to Camm & Hedges Co., Santa Rosa.

Contract for furnishing gravel for street work has been awarded to Grant Gravel Co., Healdsburg.

REDWOOD CITY, CAL.—Contract for furnishing 2300 ft. of 4-in. cast-iron pipe to city has been awarded to American Cast Iron Pipe Co., Balboa Bdg., San Francisco, for $1372.11.

RENO, NEV.—Bids will be received until April 23 by city clerk for furnishing the following motor-driven fire-fighting equipment: one combination pumping engine and hose-wagon, one 85-ft. aerial truck, one combination chemical-engine and hose-wagon, and two chassis suitable for mounting the steam fire-engines now used by the city.

SAN FRANCISCO, CAL.—Bureau of Foreign and Domestic Commerce, 306 Custom House, has information regarding firm in Ecuador that is in the market for a steam-plant and an ice-plant. Refer to No. 24016.

H. W. Johns-Manville Co. was low bidder for furnishing underground conduit material for municipal railroad.

Bureau of Foreign and Domestic Commerce, 306 Custom House, has information regarding engineer in Tasmania who is interested in high-pressure pipe-lines, wood-stave pipe-lines, and water-wheels operating under 1000 to 2000-ft. head. Refer to No. 24030.

SANTA BARBARA, CAL.—Bids will be received until 9:30 a.m., April 4, by J. M. Warren, secretary water-works department, 932 State street, for furnishing 3000 ft. of 4-in. cast-iron water-pipe, 70 rods of 58-in. Elwood fence, and 70 rods of 18-in. fence.

SANTA ROSA, CAL.—Bids will be received until 5 p.m., April 3, by H. B. Snyder, city clerk, for furnishing 450 barrels of cement.

SEATTLE, WASH.—Bids will be received until 11 a.m., April 6, by C. E. Dole, purchasing agent, Alaskan Engineering Commission, for furnishing iron, steel, bolts, nuts, washers, track-tools, and builders' hardware. Particulars from circular No. 254.

Bids will also be received until 11 a.m., April 10, for furnishing gasoline and lubricating oils and greases. Particulars from circular No. 255.

Bids will also be received until 11 a.m., April 13, for furnishing blacksmith-coal, hardware, and tools. Particulars from circular No. 259. All these circulars may be obtained from office of commission, 514 Kohl Bdg., San Francisco.

Bids will also be received until April 23 for furnishing a suction-dredge with an 18 or 20-in. pump.

SUMMERLAND, CAL.—Contract for furnishing 40,000 lb. structural steel to U. S. Department of Agriculture has been awarded to Llewellyn Iron Works, Los Angeles, for $2367.50.

SUNNYVALE, CAL.—All bids for furnishing cast-iron pipe have been rejected and pipe will be purchased in open market.

TACOMA, WASH.—Bids will be received until April 22 by W. J. Roberts, 401 Courthouse, for purchase of a second-hand 20-in. suction-dredge.

WENATCHEE, WASH.—Bids will be received until April 3 by T. L. Ross, county clerk, for furnishing one 10-ton road-roller, one 3-ton Avery truck, one hoisting-engine and boiler, one double-drum friction-hoist, one Aurora crusher, and one Port Huron dump-wagon.

WOODLAND, CAL.—Following bids have been received for furnishing pump and equipment: William L. Wales, Woodland, $808 and $865; Byron Jackson Iron Works, $955; Harron, Rickard & McCone, $985.

MISCELLANEOUS

LOS ANGELES, CAL.—Twohy Bros., San Francisco, were the only bidders at about $1,200,000 for construction of Second Street tunnel. This is considerably more than the engineer's estimate. No action will be taken until an amendment to the State law governing the construction of street-tunnels by assessment district is passed by the legislature.

McMINNVILLE, ORE.—Bids will be received until April 2 by A. C. Chandler, city recorder, for construction of a 4 by 6-ft. tunnel 1100 ft. long for water-system.

RICHMOND, CAL.—Contract for making two-foot fill over tract of 100 acres recently purchased by Standard Oil Co. has been awarded to Standard American Dredging Co., 414 13th street, Oakland.

SAN FRANCISCO, CAL.—Bos & O'Brien, Hearst Bdg., San Francisco, were low bidders at $4467 for construction of concrete sump at Commercial Street pumping-station.

BUILDING PERMITS

(Continued from page 161)

THREE STORY FRAME APARTMENTS—Cost $20,000. C. J. Keenan, owner. W Stockton 57 N Pine.

ONE AND ONE-HALF STORY FRAME DWELLING—Cost $2800. J. A. Arnott, owner. W 19th Ave 178 S Rivera.

ONE AND ONE-HALF STORY FRAME DWELLING—Cost $2800. J. A. Arnott, owner. W 19th Ave 203 S Rivera.

ONE AND ONE-HALF STORY FRAME DWELLING—Cost $2800. J. A. Arnott, owner. W 19th Ave 228 S Rivera.

MARCH 24

THREE STORY FRAME TENEMENTS—Cost $14,000. W. J. Keenan, owner. NE Atalaya and Fulton.

MARCH 26

THREE STORY FRAME TENEMENT—Cost $25,000. J. Cahen and J. Oppenheimer, owners. S Washington 105 E Presidio.

TWO STORY FRAME DWELLING—Cost $4500. E. F. Euphrat, owner. N Vallejo 87 E Scott.

UNDERPINNING LOFTS—Cost $2770. Hastings Estate, owner. E Front 87 N Pine.

TWO STORY MILL CONSTRUCTION LIGHT MANUFACTURING BUILDING—Cost $10,500. L. A. Giacobbi, owner. E Second 190 S Harrison.

TWO STORY FRAME DWELLING—Cost $5000. Allen & Co., owners. W 28th Ave 356 N California.

MARCH 28

ONE STORY FRAME DWELLING—Cost $3500. Jules Aubertine, owner. N Revere 343 E Lane.

TWO STORY BASEMENT AND ATTIC FRAME RESIDENCE—Cost $18,000. A. W. Hooper, owner. S Broadway 116-6 E Fillmore.

ONE STORY FRAME MARKET—Cost $6500. D. O'Donaghue, owner. SE California and 22nd Ave.

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